Mr. Perings Gun Carriages three No. were tried in Septr. or Octr. 1823 in the presence of a Committee of Field Officers of the Artillery with an Admiral in company.—

First by firing the Guns mounted on them, some of the thwartship bolts were broke at the end of the Service with firing, then the Carriages were placed in nearly a Triangular direction, a 24 Pounder at 300 Paces was fired at one of the Carriages, appearantly the Shot at first struck the Gun near the Vent or touch hole & carried off a part of the Gun & with the Shock broke the Carriage in the stays & sides which flew in all directions; all three Carriages were broke, the Iron appeared course & of inferior quality.— The Wheels call'd Brass appeard the colour of Lead (a composition of Copper & Lead) was also broken, the Committee declared them unfit for the Service.— 17th Decr. 1823.—

In Memory of
Richard Pering Esqre
for many years an active Magistrate in the County of Devon, who died in London 12th June 1838. Aged 70 years.
During a long life devoted to the Public Service in our Naval Arsenals, his Mechanical talents were constantly exerted for the improvement of the Navy. he was the Inventor of the Ballance Roof by which Ships of every class being built & repaird under cover are preserved from premature decay, but his genius was more conspicuous in the construction of the Anchor by which strength and powers are given to this Instrument beyond any thing ever yet devised. —
Reader remember a life which is useful to mankind is pleasing to the Almighty. —

Kensal green Cemetery June 1846

Robt Rennie

A

TREATISE

ON

THE ANCHOR,

SHEWING HOW THE

COMPONENT PARTS SHOULD BE COMBINED

TO OBTAIN

The greatest Power, and most perfect Holding,

WITH

A Table of Dimensions,

Graduated from 1 to 95 Cwt.

AND

A SCHEDULE

OF PROPORTIONATE

WEIGHTS OF ANCHORS

SUITABLE TO THE

TONNAGE OF EVERY CLASS OF VESSEL,

Both as to his Majesty's and Merchants' Ships,

WITH

A RECOMMENDATION FOR THEIR BETTER SECURITY IN ANCHORING.

ALSO,

SOME OBSERVATIONS

ON

THE CHAIN CABLE,

Shewing the Proportion it bears to that of Hemp, and to the Weight of the Anchor.

BY RICHARD PERING, ESQ.

Clerk of the Checque of his Majesty's Dock-Yard, Plymouth.

PLYMOUTH-DOCK:

Printed and sold by CONGDON and HEARLE, 52, Fore-Street;

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1819.

TO THE

ADMIRALS AND CAPTAINS

OF HIS MAJESTY'S NAVY,

THE

HONORABLE EAST INDIA COMPANY,

THE

UNDERWRITERS AT LLOYDS,

AND

THE SOCIETY OF SHIP-OWNERS,

THESE

OBSERVATIONS

ARE, WITH EVERY DUE CONSIDERATION, MOST

RESPECTFULLY SUBMITTED,

BY THEIR VERY OBEDIENT AND MOST

HUMBLE SERVANT,

RICHARD PERING.

PREFACE.

THE *Author of the following pages, in laying them before the public, would fain persuade himself that they involve matter of deep interest to the country, which, if properly received and acted upon, may lead to a considerable saving, both of British lives and British treasure.*

The Anchor, of which they treat, is already known to the public, but the mechanical principles of its construction, and the important ends to be attained by adopting the Author's recommendations, not being understood, it is the design of the present Treatise to communicate them for the general good of the world.

In pursuing this subject, attention has been principally directed to the manner in which an Anchor ought to be *formed to combine strength and efficiency, and to censure the defective mode heretofore, and even now, too commonly practised.*

The Author's sentiments are the result of long and arduous application, and his progress has often been impeded by the necessity of close investigation, and the tediousness attendant on a series of experiments.

Various persons have written upon the construction of Anchors: some have merely touched on the subject—others have entered more into detail—but none describe a proper plan for forming and putting together the component parts. Instead of this, they leave to the workmen the practical part, and content themselves with theoretical suggestions; but theory alone is not sufficient in framing a machine of such vital consequence to navigators and merchants. The Author has endeavoured to supply this deficiency, by uniting theory with practice, and founding thereon their best basis—successful experiment.

It is the Author's duty to acknowledge, before he enters on this interesting topic, that much attention has been paid to his various Suggestions on Naval Economy, and he humbly trusts, that the nation will ultimately receive from them all, the benefit they are capable of producing.

ON THE ANCHOR.

IT is much to be regretted that the Anchor, that essential accompaniment of every ship, and its principal safeguard and hope, should have remained so many years inefficient, as it were, to the great purpose it is designed to effect, and without any practical treatise on the improvement of which it is susceptible in manufacture.

It is also to be regretted, that no two nations have ever adopted an anchor alike in shape, proportion, and component parts.

The merit due to the original inventor of the anchor, with two flukes, cannot be too much extolled—the peculiar ingenuity of its form could in no other shape find a substitute; combined with the stock, it makes the ma-

chine complete. The inventor has unfortunately shared a similar fate to him who invented the Mariner's Compass, and to various others, whose ingenious improvements are adopted, whilst the authors remain unknown.

The difficulty of forging an anchor of large dimensions is very great, it being a machine which necessarily calls to its aid the utmost exertions of human power, and much ingenuity, to accomplish. It is not easy to name a piece of mechanism wherein bodily exertion is more required, or muscular power is brought more into action. The management of a huge unwieldy body of iron, to form an anchor of five tons, repeatedly required to be taken red-hot out of the furnace, to be hammered to a proper moulding, and again returned, is a task of no easy comprehension, but to those familiar with the mode. A finer subject for the pencil of the artist is scarcely to be found.

The anchor is an instrument of very ancient use. It derives its name from the Latin, *anchora*, and originally from the Greek. Pliny, *(lib.* 8. *c. ult.)* ascribes the invention of it to the Tuscans; and Pausanias, *(attic. lib.* 1. *c.* 4. *p.* 12.) refers it to Midas, the son of Gordius, who built the city Ancyra. The most ancient anchors, we are told, were

made of stone, and sometimes of a crooked piece of wood, to which lead was attached to make it sink, and to stay the course of the ship. These are not altogether thrown aside by the Chinese, in mooring their junks, even to this day. Afterwards anchors were constructed of iron, and furnished with flukes. The contrivance was completed, according to PLINY, by EUPALAMUS; or according to STRABO, (*lib.* vii. *ex Ephor. tom. p.* 464.) by ANACHARSIS, the Scythian, every ship had several anchors, the largest of which was held sacred, and never used but in extreme danger; whence the phrase, *sacram Anchoram solvere*, is proverbially applied to such as are reduced to their last refuge.

The anchor-smiths hold ST. CLEMENT as their tutelar saint, being the earliest of the most eminent Fathers of the Christian Church, when it shone in all its primitive lustre. CLEMENT was a Roman by birth, and converted to the faith by the Apostles, whom he aided by turning all he could to the true belief, with such pious zeal and unremitting attention, as to be styled their immediate disciple and coadjutor; he is said to have been one of those who lost their lives in support of their faith; and to have been a great friend to all artizans, particularly to the smiths, who celebrate his memory to this day, by keeping holiday on the 23d of November; and those

who work for Government are allowed 1s. 6d. each, to commemorate the ancient custom. Clement himself is said to have been cast into the sea with an anchor about his neck, which was a common method of execution among the Romans. To this legend St. Clement owes the emblematical badge assigned to him of *an anchor;* which device may be seen, at this time, on several parts of the parochial church of St. Clement Danes, London.

The first mention of a worker in iron is in holy writ—Genesis, chap. iv. verse, 22. Tubal Cain, an instructor of every artificer in brass and iron, is noticed in several places in the *Pentateuch*, particularly by Moses in his descriptive eulogy of the Land of Promise. On the decrease of the flood, we are told, that the ark *rested* on the mountains of Ararat. A thousand years before the Christian era, we are informed, in the account given of Solomon's very great riches, that he had at sea separate navies, bringing gold and silver, ivory, &c. Herodotus, in speaking of the Egyptian vessels, says, "their vessels of burden are constructed of a species of thorn, which resembles the lotos of Cyrene, and which distils a gum. From this thorn they cut planks, about two cubits square. They do not use timber artificially carved, but bend the planks. They have one rudder, which goes through the keel of the vessel,

The name of this kind of bark is Baris, &c. They have immense number of these vessels, and some of them of the burden of many thousand talents."

The most celebrated ships of antiquity were those of PTOLEMY PHILOPATER, one of which we are told was 280 cubits long, 38 broad, and 48 high; it carried 400 rowers, 400 sailors, and 3000 soldiers—that which the same Prince made to sail on the Nile. Yet these were nothing in comparison with HIERO's ships, built under the direction of ARCHIMEDES, on the structure whereof, MOSCHION, as represented by SNELLIAS, wrote a whole volume. Wood enough was employed in it to construct fifty gallies; it had all the variety of apartments of a palace, banqueting-rooms, &c.; it was encompassed with an iron rampart and eight towers, with walls and bulwarks, furnished with machines of war, particularly one which threw a stone 300 pounds, or a dart 12 cubits long, the space of half a mile, with many other particulars related by ATHENÆUS.

Of the particular method used by the ancients for securing their ships, we are not altogether informed: that they used many anchors, there can be no doubt; and moored both a-head and a-stern, we are told of ST. PAUL, in his voyage to Rome, XXVII. chap.

of the ACTS OF THE APOSTLES, verse 29. 30. "Then fearing they should have fallen upon rocks, they cast four anchors out of the stern, &c. and after this they would have cast anchors out of the foreship." In *Beloe's Herodotus*, vol. III. page 269, mention is made of wooden anchors being used in the East; and there belonged to the large ship made for King HIERO, eight anchors of iron, and four of wood. The Phœnicians used lead for some part of their anchors; for in a voyage which they made to Sicily, DIODORUS SICULUS says, they found silver in such great abundance, that they took the lead out of their anchors and put silver in its place.

The first man of war, carrying heavy cannon, that was built for the Royal Navy, was in 1485. Its progressive increase is minutely detailed in *Derrick's Memoirs*, to 1805; wherein he states, that the Sovereign of the Seas, built in 1637, had eleven anchors, one of 4,400 pounds weight, which, compared with ships of a similar class in the present day, is very small. The largest anchor now used is 10,976 lbs. being 4 tons, 18 cwt.

When the Navy was in its infancy, more anchors were used, to stay the ship in a storm, than at present; and what was then effected by many, is now better accomplished by a few. In anchoring, the skill of the sea-

man is ever wanted to prevent the fluke of the second anchor injuring the cable of the first, and more so when the third is from necessity called into use.

When the ancients moored their ships, they cast anchor from the head and from the stern. The present method of mooring ships in a river or haven, sheltered from the wind and sea, is to cast an anchor, and veer cables thereon to two in length, then to drop a second anchor from the opposite bow; while veering on the second anchor, the ship, being hove a-head one cable's length to midway, is moored.

Anchors, when on board ship, are distinguished by the appellations of sheet, best-bower, small-bower, and spare anchor: these vary but very little in form or weight. The smaller anchors are called the stream and kedge: the former being used to ride in rivers, or to stay the vessel a short time; the latter, being very light and easily managed, is found very convenient to stop the ship in working up, or kedging a river, to steady the ship when at single anchor, and to prevent her *yawing* from side to side. The sheet anchor, though varying but little in weight, is the heaviest and strongest, being the seaman's best hope, and seldom used but in cases of great extremity. So much

consequence was formerly attached to the use of this anchor, that whenever it was let go, a reward of £5 was awarded the master of the ship, for the extraordinary vigilance necessarily required of him, during the time the sheet anchor was down: it was called by the Romans *anchora sacra*. The bower anchors are the common working anchors of the ship, by which she is commonly moored.

The several parts of the anchor are the shank, ring, square, nuts, small of the shank, trend, crown, flukes or arms, palms, and bill.

The length of the arm, taken from the inside of the throat to the bill, is the distance marked on the shank for the trend, which being extended to the bill, from the side of the shank, gives the angle of the arm, forming an equilateral triangle, and three times that is the length of the shank, taken from the tip of the crown. The anchors with this proportion of shank are always preferred; the seamen assigning as the reason, that they ride the ship much better than when shorter, and that the anchor is weighed easier when the fluke has deep hold in strong ground, by the increased lever. It is experience herein that must be our guide.—It would be the height of folly to apply a long shank to an anchor, if a short one would equally answer the purpose, for the following reasons:—the

anchor would be stronger in proportion to its decreased length; and though shortened, if allowed to retain the same weight, the quantity diffused throughout the remaining part would, of course, increase its bulk. Notwithstanding the short shanked anchor has been thrown aside for many years, I am informed it has, in many instances, been again introduced into the Merchant service, under a persuasion that the long shank is not sufficiently strong when attached to a chain cable. It would therefore appear, from these contradictory opinions, that the ancient anchor, with a short shank, is on the the true principle—that the seamen of the present day have been mistaken—and that the idea of a long shank riding the ship better, is merely theoretical. To these observations I have to remark, that every seaman, of whom I have asked an opinion, has invariably given it in favour of the long shank. If the component parts of the anchor be wrought in the manner herein described, according to the new principle, it will not break, whether the shank be of the present length or shortened, as in no instance has it taken place; and, in many instances, both the chain and hempen cables have yielded to its superior strength. It is not for me to advise the seaman unto whom the practical use is confided on that particular point—he must judge for himself. An anchor for a first rate, lately made on my principle, being sent on

board, was returned to the Dock-yard by the noble admiral, who subsequently observed, that it was too short in the shank.

Various persons have written on the construction of anchors, and some have entered more into detail than others; but very few have fallen under my observation who describe the method of forming the component parts, and putting them together. Instead of this, they leave the workman to find out improvements, contenting themselves with his suggestions; by which it would appear, that the information they have given has been obtained, not from experience gained by their own practical observation, but from the artizan.

The following are among the authorities on the subject, from early date nearly to the present period:——ATHENÆUS, DIEPNOSOPH, APOLLONIUS RHODIUS, STRABO, PLINY, BOUGUER'S *Traite de Navire, p.* 95.—AUBIN'S *Dictionnaire de Marine*—DUHAMEL'S *Art de la Fabrique des Ancres*—FOURMONT'S *Hydrographie*—*Arts et Metiers, tom.* i *p.* 6, 7, 8, 31, 37, 40.—PERRAULT'S *Machin approuve, tom.* i. *p.* 45.—J.BERNOUILLI'S *Recueil des Pieces qui ont remporte le prix, tom.* iii. *m.* 4.—TRESAGUET'S *Recueil, &c. tom.* iii. *m.* 5.—DAN. BERNOILLI'S *Recueil, &c. tom.* iii. *m* 5. & 6.—MARQUIS DE POLENI'S *Recueil, &c. tom.* 3, *m.* 7.

—Smeaton's *Reports*—Manwaring, Falconer, Chapman, Gilbert's *Journal de Physique, vol.* vi. *p.* 81.—*Philosoph. Magazine, vol.* xxxiii. *p.* 348.—Murray's *Treatise on Ship-Building, &c.*—*American Philosophical Transactions, vol.* ii. *p.* 311.—*Ship-Builder's Assistant*—*Elements and Practice of Rigging and Seamanship, vol.* i. *p.* 77.—Young's *Natural Philosophy, vol.* iii.

Sir H. Manwaring, in his *Seaman's Dictionary,* states "for the proportion of anchors, the shank is to be thrice the length of one of the flukes, and half the length of the beam. According to M. Aubin, the length of the anchor is to be four-tenths of the greatest breadth of the ship; and he gives a table, from a Flemish writer, for the lengths of the shanks of anchors for vessels of all widths, shewing, by means of the ship's breadth, how many feet the beam or shank ought to be, allowing it four-tenths or two fifths of the ship's breadth within. M. Bouguer, in his *Traite de Navire,* says, there is a ready way to find the weight of any anchor, by taking the length of the shank in inches, and dividing the cube of that by 1160, which will give pounds. But if the weight were given, and the length required, we must multiply the weight by 1160, and the cube root of the product will be the required length in inches. These operations, he observes, may be facilitated by the logarithms,

only taking three times the logarithm of the shank in inches, and from thence subtracting the constant logarithms of 1160, which is 3.0644580, the remainder will be the logarithm of the weight of the anchor in pounds. The smallest ships have five or six anchors, and the largest generally eight. The mariners have different rules for determining the weight of the anchors; and, for the conveniency of working the ship, they have established it as a rule, that the biggest anchor, or, in their terms, the master anchor, should be, in length, three eighths of the beam. Another rule is to make it weigh half the weight of the cable to a first rate, which taking her breadth forty-eight feet, and her cable at twenty-four inches in circumference, being 13824 lbs. her master anchor should weigh 6912 pounds, and the other anchors should be half the weight of their respective cables."

When such data as these are offered to the public, as documents for general use, it is to be supposed that they have been duly considered, *a priori;* but in the circumstantial detail of the local economy of the different Marine departments, they are too often swelled out with various matter which had better be treated on at large, under separate heads, particularly with respect to the instrument in question. As vessels of equal breadth of beam vary considerably in tonnage, such

data for determining the length and weight of the anchor must be extremely erroneous, and, if followed, would be attended with disastrous consequences. Vessels equal in length of beam, frequently double each other in actual capacity.

The difference also in point of admeasurement, between the common mode of calculating tonnage, and that of the actual capacity, is very considerable; the former is found by multiplying the length by the breadth, then by the half breadth, the product to be divided by 94; and the latter by the actual cube or displacement of the ship in the water.

The common admeasurement of a first rate may be 2615 tons—her absolute capacity 4589 tons.—A 74, 1842 t. . . . a. c. 2799.—A frigate, 1148 t. . . . a. c. 1570.—A sloop, 419 t. a. c. 527.—A merchant brig, 180 t. . . . a. c. 324.

This evinces also, that the common tonnage of the ship, if taken as a standard, can form no certain data, with regard to the tonnage that one ship bears to another, for ascertaining the weight of the anchor, no more than the breadth of beam; nor would the absolute capacity produce a nearer standard; as in one instance, the small anchor would be too light, while the larger would be too heavy,

and so *vice versa.* Small ships, in many cases, require an anchor heavier in proportion to the actual cube of the ship, than those of larger dimensions. A vessel of 400 tons will require an anchor of 20 cwt.; but a ship of 2600 tons one of only 95 cwt.; to apportion the latter to the weight of the former tonnage it would be 130 cwt. The capacity of a vessel of 180 tons, built for fast sailing, may be considerably less than her common admeasurement; whilst another of the same common tonnage proportion, built for burthen, would be 144 tons more, in which case the weight of the anchors of both vessels would be alike; therefore it is from experience only that we can respectively apportion the weight of the anchor to the tonnage of the ship, by a gradual increased proportion to the smaller vessel.

A ship and brig of equal capacity, will not be equally stayed by an anchor of the same weight, if it be proportioned to the latter vessel; nor will a schooner and a cutter of similar dimensions; for the greater the number of masts and yards, and the higher the ship swims, so much the more will be the strain on the anchor, to meet which, the table annexed to this work is calculated to the full proportion; and although the ship be changed into a brig, the propriety of maintaining the weight of her anchors cannot

be questioned, when we bear in mind that an anchor and cable cannot be too strong.

With respect to the particular anchor introduced to the reader in this treatise, I may briefly observe, that after a perseverance of nearly nineteen years, (during which long period several trials with other anchors have taken place, over which it has invariably held the superiority,) it is at last so fortunate as to receive praise in every quarter, and be established throughout the British Navy.

The inducement that first led me to the study of this most useful machine, was the unmechanical and dangerous methods employed in manufacturing anchors, of large dimensions, in his Majesty's Dock-yards; about which time, (viz.) on the 18th of November, 1800, the Navy Board was pleased to direct a general letter to be written to all the Dock-yards in the kingdom, on the subject of anchors, of which the following is an extract:—

"As many serious complaints have been "made of the anchors now in use, and being "extremely desirous of giving them every "possible degree of strength that can be "obtained, you are very maturely to consider "this important subject, and propose to us "any thing you may consider as likely to "accomplish so desirable an end."

On the 8th of January, 1801, having given the subject a mature consideration, I transmitted my plan, together with models, proposing to make all anchors, in future, on the principle of a truss-beam, and without any joinings at the crown, to which the Board was pleased to give the following reply :—

"*Navy-Office*, 19*th Jan.* 1801.

"Mr. Pering,

"We have received your letter of the 8th "instant, containing your suggestions upon "the mode of making anchors, and acquaint "you we are much pleased with your attention "to this subject, and consider your proposal "as very ingenious; but the adopting of it at "present would occasion so many applications "for a change of anchors of the fleet, that we "think it better to defer it until a peace may "afford a better opportunity of determining "its merits.

"We are, &c."

It would be needless to enumerate the correspondence which took place between the date of this letter and the one next cited, being a period of seventeen years, without the adoption of what the Navy Board had approved so much. At the end of that time, the Honorable Commissioners forming the Board at present, to whom I feel much obliged, favored me with a most satisfactory letter, of which the following is a copy :—

"*Navy-Office, 25th August*, 1817.

"GENTLEMEN,

"We have to acknowledge the receipt of "your and of Mr. PERING's letters, of the 19th "instant, with the Drawings of the French, "Dutch, Danish, and Spanish, anchors, which "accompanied them; and we have to state, "for Mr. PERING's information, that the en- "quiries which we have made upon this "subject, have fully convinced us of the "advantages which may be obtained by per- "severing in the mode which he has recom- "mended for making anchors in future, and "that we shall give him every support and "assistance therein which may be in our "power; being fully convinced, that the "merit of the new system is wholly due to "him, and that the mode of making anchors, "practised by the nations above-mentioned, "as appears by the drawings, has no simi- "larity to his system.

"We are, &c.

"*Plymouth Officers.*"

The foregoing letter, although highly satisfactory, did not, as I was led to expect, finish the correspondence, nor put the question at rest. Messrs. BRUNTON & MIDDLETON, Chain Cable Manufacturers, Commercial Road, London, offered an anchor, purporting to be made on new principles, and superior in every respect to any yet manufactured. The Navy-

Board thought proper to direct an anchor to be sent, by Messrs. BRUNTON & Co. into Deptford Dock-yard, which weighed 28 cwt. to be forwarded to Plymouth Dock-yard, and there tried against an anchor of equal weight, made on my principle, which, on being landed, engaged the attention both of seamen and anchor-smiths. After a long correspondence with the Board, and its remaining in the Dock-yard for some weeks, the anchor was ordered to be returned to Messrs. BRUNTON & Co. This terminated the correspondence on anchor-making, and established the principle which I had recommended nearly nineteen years before.

Before I explain fully the particulars of my anchor, it will be proper to say a little concerning the mode heretofore practised, in constructing anchors for the British Navy, as well as for the Merchant service; in doing which, I shall be under the necessity of pointing out some errors in that construction, and the evils which have from time to time resulted from it. It is painful to be under the necessity of expressing myself in the manner I am obliged to do if I speak the truth; but it is far from my wish to cast censure on any individual, and I would that I were not circumstantially borne out by facts, which have proved themselves too often fatally conspicuous.

There is not, I believe, to be found in any branch or department of art or mechanism, such a defective and deceitful piece of workmanship as an anchor, made on the common principle, considering its peculiar and important uses; whilst, confessedly, it ought to be the most perfect instrument within the powers of human invention; and it may be considered as rather singular, that although many other things, connected with our Navy, have met with repeated attention, yet the instrument on which the safety of our fleets and their crews, when riding in furious gales, mainly depends, has hitherto escaped observation, as if it were altogether undeserving notice. No efforts have been made to ascertain the possibility of improving it, or to impart to it that firmness and durability of construction, which the trying nature of its services so imperiously require; although thousands of lives, dear both to society and their country, have been lost by its giving way, from defective formation.—His Majesty's ship Brunswick, Captain Graves, in 1808, carried away her anchors in the Baltic, and in order to moor, was obliged, as a forlorn hope, to lower her only remaining one, and that imperfect, one arm being gone. The melancholy catastrophe of his Majesty's ship St. George, in the Baltic, in December, 1811, an event of anguish to the whole kingdom, may be entirely ascribed to the defec-

tiveness of her anchors, one of which broke in the ring, and another lost an arm: from this cause the ship went on shore, lost her rudder, and cut away her masts: after beating over a bank, she was held on, for a short period, by her other anchors; but on again getting into deep water, under jury masts, and making much lee way, with a foul wind, she got a second time on a lee shore, stuck, and soon fell to pieces. Had her anchors been good, this dreadful event might not have happened.

The afflicting loss of the Seahorse, Boadicea, and Lord Melville, transports, which took place on the coast of Ireland, in 1815, cannot be remembered without serious regret. The former ship had a detachment of the 58th regiment on board, consisting of about 16 officers, 287 men, 35 women, and 34 children. By stress of weather, and overshooting the harbour, she was driven into Fremore Bay, where two anchors were let go, which she dragged as if she had nothing at her bows; consequently she soon struck and went to pieces, in mid-day: 31 persons only in this ship were saved. Of 280 of the 82d regiment, on board the Boadicea, 220 were lost to their country and friends. The Lord Melville transport underwent a like fate. It is painful to reflect, that merchant vessels often sail, improperly found in sails, an-

chors, cables, and men; parsimony being the ruling object, and the insurance, ostensibly, the sheet anchor. A merchant ship happening to be embayed, with the wind direct in; having her sails, perhaps, shattered, if not blown from the bolt-rope, has no resource but her anchors and cables—these are her ultimate hope; but even on these no reliance can be placed, unless they be sufficiently apportioned to the contending impetus they have to withstand. From the want of these, the lives of our Waterloo heroes were lost, within sight of their own shores, after escaping the cannon and carnage of that glorious day.—Merchant vessels are not only too frequently ill-found in their ground tackling, but built in a very loose manner, most improperly fastened, and often deficient in every respect that affects the safety of the ship.

On mature reflection, I cannot call to my mind any pieces of workmanship so insecurely and parsimoniously wrought, as a ship, and the anchor. How far these remarks are correct, Lloyd's list of ships lost and foundered at sea for the last twenty years, will sufficiently prove. I might quote instances almost without end of similar disasters; but it is not a pleasing task, and I shall therefore content myself with mentioning only one more, and that of a recent date:—the Jasper brig, Lapwing revenue cutter, and Telegraph

schooner, with the Princess Mary, a Falmouth packet, were wrecked in Plymouth Sound, in January, 1817, principally from breaking their anchors, as reported by the Officers of Plymouth Dock-yard. Of 67 persons on board the former ship, all perished but two; and in the packet, six or seven persons, including the master, his wife, and children; independent of a great destruction of property.

Hundreds of broken anchors repaired in Plymouth Dock-yard, as well as numbers repaired in other Dock-yards, demonstrate to conviction that there must be something wrong in the workmanship, undue proportion, or the manner of combining the materials. Continual complaints, by Commanding Officers of the Navy, on this score, furnish additional proofs of the fact.

The unmooring of a fleet has too frequently been attended by the breaking of anchors, both in our own and foreign ports.—Although during so many years, sad experience daily shewed something was wrong in anchor-making, yet instead of devising one new and approved method throughout the navy, each Dock-yard in the kingdom had its peculiar mode of manufacture; every master-smith, and his workmen, of course, conceiving their own plan to be the best. If

a question were asked, why an anchor was put together in that particular way, the reply was, we have never been in the habit of doing it otherwise in *this* Dock-yard: their predecessors did the same before them, and they knew of no other method. It is from such prejudices that anchors have been put together in so improper a manner.

I cannot more forcibly record the want of consideration for the easement of labour, and the strong predilection for adhering to old habits, than in the following occurences:---in order to turn the anchor when taken out of the fire to place it on the anvil, it is necessary that one arm of the anchor should pass below the regular surface of the ground, into a hole several feet deep, formed for the purpose, the anchor being slung to a crane, on an equipoise, by the shank. It had always been customary, until the year 1815, to excavate this hole when the anchor was about half finished, and to fill it again when the anchor was completed; in which state it remained until the flukes of the succeeding anchor were ready for welding. To accomplish this excavation, close to the intense fire of the anchor-furnace, was no trifling task; and it was with difficulty and hard labour that four men could excavate a pit, five feet deep, and as many wide, in an hour. So toilsome, indeed, was the undertaking to those who performed

it, that they always received a reward of strong beer from their fellow-workmen, for their extraordinary exertion.

In order to avoid the waste of so much time and manual strength, I proposed simply to form, at each anchor-furnace, a hole, to be cased with brick, in an inverse arch, and to cover it with plank, to be removed when necessary; the result of which is, that two men now accomplish, without the least difficulty, in two minutes, that which before occupied four men for one hour; avoiding also the interruption occasioned by the mound of dirt, which always lay by the side of the hole. It is hardly to be believed that a century or upwards should have gone by, and that no succeeding smith in the Dock-yard, during so long a period, should have suggested this simple means of lessening so much painful labour.

I must now premise, that all anchors in his Majesty's Dock-yards are both made and repaired after my plan; but before I explain this new system, I shall first point out the manner in which they have heretofore been put together. The shank was formed round, by a number of small bars hooped together in a bundle, large enough to allow for waste; slices or wedges of iron about two feet long, being driven in at the large end of the shank

and arms, previously to their being welded, sufficiently numerous to make up for the waste of iron in welding on the arms; these, though struck with a heavy hammer, swung by the smith, when taken out of the fire were only cemented about an inch and a half in depth. The shank, consequently, remained hollow in the middle, and the centre bars were left perfectly at rest.

A large body of iron should always be wrought under a blow sufficient to reach the centre, which, in our Dock-yards, the sledge-hammer, swung only by the strength of a man, is unable to accomplish. From this want of power, the welding has been little more in general than superficial; and, besides, an imperfection is thus created, which destroys the ductility of the iron, by stretching or expanding the outer parts, while the inner are left unaffected.

When the shank and arms of an anchor are formed round, the arch is compressed, by the blow of the hammer, into a less space; and in the endeavour to do that, which the very principle of arch-building so strongly resists, (namely, the beating of an arch into itself) loses its ductility, and grows brittle by the closing of its pores, which I have carefully avoided, by forming them into an oblong flat, and working them under the *Hercules*, a

heavy hammer, that strikes a blow equal to several tons weight.

The square end of the shank, to which the ring was connected, was also formed of small bars, and welded to the upper part, a little above the stock, by a short *scarph* in the small of the shank; the arms were next hooped together, in a round body, allowing for the tapering; and on being externally welded, with the palms attached to each, were separately joined to the shank, and formed straight, at an angle of 52°. 55′. But little penetration is required to perceive that an anchor so made must be inefficient.

Not long since, I observed an anchor, which had been returned from the fleet, weighing 73 cwt. broken close under the crown. I counted the ends of thirteen short pieces of iron, in the shape of wedges, that had been driven in for the purpose of swelling the crown, not one of which had been welded. The anchor was quite hollow in the middle, and all that held it together was the shallow incrustation of iron on the outside. I have examined many others, and always found them more or less in the same state. On the 11th of May, 1812, an anchor was returned from the Hannibal, 74, of 69 cwt.: this had lost an arm, and was broken under the crown, in the incrusted part of the shank, which in-

crustation was not merely separated from the interior bars, but in such a manner as to make the anchor one inch longer than when it was first made. In June, 1815, an anchor of 81 cwt. having lost an arm, was sent from the Tonnant; and this was the *third time* the same anchor had been returned into Plymouth Dock-yard, in a similar state.

Let any thinking man reflect for a moment, whether a bundle of iron rods, bound together with nothing more than a shallow incrustation on the outer part, deserve the name of an anchor, and be an instrument on which the safety of our fleet and sailors should depend—humanity shudders at the thought. On my asking an anchor-smith why he formed the bars of his anchor in this manner, he replied, because it resembled a bundle of laths, in which each has to bear an individual strain; forgetting that while the laths act loosely and individually, the bars of iron are prevented by the outward incrustation from opposing an individual resistance. The rounded form of the shank and arms militated much against their capability of sustaining the power opposed to them, the former being more fortified at the crown, when it should have possessed its strength at the *trend*, about one third of the way down; and the latter wanting proportion in the small of the arms. The three parts being cemented to-

gether at the crown, were seldom well executed, owing to the extreme difficulty which the workmen had to strike an effective blow in the throat, after the arms and shank had been brought together, which has been the principal cause of so many anchors breaking in this part. So general were the complaints by the officers of the Navy, that directions were given for all anchors made by contract to be heated in this part, in the smithery of the different Dock-yards. Several hundreds of English and Foreign anchors, particularly the latter, have been proved defective in Plymouth yard only. Many that have stood the fire-proof have subsequently broke when brought into use. If a defective anchor be not wholly re-manufactured, except the arms be too small, it is useless attempting to strengthen it by adding iron partially; for unless the shank can be increased, (which under a partial repair is impracticable) and the whole wrought into an uniform proportion, the anchor will bear no more than its weakest part, and at a great additional expence be rendered still more deceptive. The rings are also, in many instances, too large in diameter, and deficient of iron: all that is necessary is a proper accommodation for the seaman to cat the anchor.

Another great defect in anchors has arisen from the palms being made too thick; and

thus the other parts of the anchor are deprived of the iron which might have been much better disposed of.

Notwithstanding the evils I have already pointed out in the construction of anchors, their shape is the most reprehensible. The arms are made straight—a greater error than this could hardly have been introduced, which makes our anchors differ in shape from those of every other nation. This distinction, it might have been supposed, would have provoked inquiry. The straight arm possesses evident weakness; for if formed in a curve, the resistance it has to sustain is aided by a most powerful auxiliary—that of the arch; which shape also is far better for holding and gathering into the ground, if the palm be brought to a proper angle.

When a ship is riding by two cables on end, the cable passing from the bows to the anchor makes an angle many degrees less than when she rides only by a single cable. The anchor in this position, having a larger scope of cable, will hold much better, and with more ease and safety. When, however, a vessel is riding by one cable, in a heavy sea, on a lee shore, and perhaps in less than thirty fathoms water, the shank of the anchor partakes of the motion, in proportion to the lift of the sea on each

succeeding wave; and being dragged in the ground, the clay or sand filling up the chasm left behind the fluke, forms an abutment for the upper part of the straight arm to rest on; as the ship ascends or lifts, it is thereby forced from its hold, and if not strong enough to break the ground before it, or to clear itself at one effort, the arm must give way, which I am inclined to suppose, was one cause of the ships beforementioned breaking their anchors in Plymouth Sound, in January, 1817. In a subsequent storm, which happened in March, 1818, it was reported to the Commander-in-Chief at the port of Plymouth, (Admiral Lord EXMOUTH) that three of my anchors had given way. The reverse, however, was the case; for it appeared, on investigation, that one anchor was parted by the Drake, while riding in Cawsand Bay, and two by the Pigmy, lying between the Island and Main.

The former ship had broken her anchor, and the latter parted an anchor and cable—but both of these were on the old construction. The anchor, to which the cable broke, was on my principle, as was also that (her only remaining one) by which she rode out the storm; the consequence otherwise might have been fatal to the vessel and her crew. The remaining two anchors which stayed the Drake, were also on the improved principle.

The Dunirah, East Indiaman, lying in Plymouth Sound, outward bound, drove considerably with two anchors a-head, in the same gale, but was fortunately brought up by her third. The Erne, 20 gun ship, lying by her side, rode out the storm by one of my anchors, without driving in the least degree.

I am much indebted to Captain Dix, and the Officers of his Majesty's ship Menelaus, who were perfect strangers to me, for the following letter :—

"*His Majesty's ship Menelaus,*
"*Plymouth Sound, August* 10, 1815.

"Sir,

"An anchor of your construction was re-"ceived on board this ship in May, 1814, and "after the fairest possible trial of its general "service, with respect to other anchors, we "have to say, that the Menelaus rode out "the last winter (which was very severe) in "Lynhaven Bay, Chesapeake. The ship had "been driving with one cable and a half out, "on another anchor, when, under the same "circumstances, your anchor has invariably "brought her up: also the state of the ground "of the anchorage was such, that several "ships lost the arms of their anchors: en-"closed is a list of the ships, which we be-"lieve to be among the number; and we

"have further to state, that on no occasion "has the ship drove, when riding by your "anchor, although every ship of the squad- "ron at the same time, has dragged her's, "more or less.

"We also particularly observed, that your "anchor, when up and down, weighed with "greater ease than any other.

"The only improvement which we can "recommend, is a little increase in the size "of the ring, there being scarce room for the "clench of the cable, and working the cat.

"We are, &c.

"Signed
"EDWARD DIX, Captain,
"HENRY CREASE, Senior Lieutenant,
"R. COLLINS, Master.

"*Richard Pering, Esq. Dock-yard,*
"*Plymouth.*"

The Menelaus when she sailed from England, was commanded by Captain Sir PETER PARKER, and after his unfortunate fall in America, by Captain DIX. During the winter of 1814, the Euryalus and Havannah, forming part of the blockading squadron of the Chesapeake, lying in Lynhaven Bay, (an open roadstead) were blown to sea from their anchors, whilst the Menelaus (forming one

of the same squadron) with my anchor a-head, was at no time known to drive; she carried away two arms from two of her other anchors, and according to the report of the Officers, and on reference to the ships' logs, each ship of the squadron broke her anchors, more or less.

The Eridanus, Captain WILLIAM KING, (an officer and seaman well known in the British navy) when laying at Spithead, in June, 1817, with four other frigates, in a gale of wind, says, "with the exception of ourselves, all, more or less, drove, particularly the Euphrates and Tiber—on all occasions when your anchor held the strain, all on board felt perfectly satisfied; as long as the cable was good, it was next to an impossibility our starting."

An anchor of 84 cwt. being made for trial, was issued to the Impregnable, Captain C. ROWLEY, who, in a letter of the 10th of Nov. 1815, says, "we have not experienced any severe gales while at anchor, but in every appearance, as far as we have tried it, we find it to answer very well. The other bower lost an arm in weighing in Gibraltar Bay." The number of broken anchors repaired in Plymouth Dock-yard only, between the 6th of November, 1809, and 29th June, 1812, was 361, and there still remained for repair

180. Although these anchors were some time in accumulating, it serves to confirm the defectiveness of the principle on which anchors have been heretofore made.

To shew further how very improperly anchors have been formed, a piece of an anchor was hung up in the smithery of Plymouth Dock-yard, with the following inscription:—
"Part of an anchor of 43 cwt. 3qrs. 21lb.
"returned from the Loire, 23d January,
"1811, made by contract, under the firm of
"***********. This is their twenty-third
"anchor reported to the Navy Board, from
"Nov. 1809, to Nov. 1811, on account of bad
"workmanship!"

How many anchors were in the like state, in other Dock-yards, I have not the means of ascertaining; but that a large proportion of the contract anchors is very bad, as well as many made in the Dock-yards, is too true. Some hundreds of the former have proved defective on trial, and are laid aside; and so reprehensibly negligent have the workmen been, in some instances, that by heating the anchors only in the crown, they have fallen to pieces by their own weight—both arms dropping off without a blow. I profess to speak not only of anchors made for his Majesty's service, but those also for the Honorable East India Company; and have to observe,

that the anchors of the Merchant ships, though less in weight, are too frequently in the like predicament. So extremely prejudiced were anchor-smiths, with whom I have conversed on the mode of manufacture, that they obstinately persisted in maintaining, that if anchors were made solid, they would become brittle; and not until experimental proof to the contrary could they be led to alter their opinion. I must now do them the credit to say, that they have candidly acknowledged they had formed their opinions in error; allowing, at the same time, the shape to be improper, and in many parts ill proportioned.

In the Merchant service there are two causes which militate greatly against obtaining good anchors: one of them is, the very mistaken idea of going to market cheap; the other, the facility which the anchor-smith has of making his anchor of inferior iron, the price being sometimes as low as eight pounds a ton, whilst good iron is worth twenty. Such a tempting profit, is not, I fear always resisted. But still the purchaser is not warranted in lessening the price of an anchor below a fair and marketable profit, on iron of the first quality; and although it may sometimes happen, when the owner of a vessel imagines that he has not an immediate interest in her safety, owing to her being insured to her

full amount, yet he should not forget those who underwrite her. What, however, ought principally to guide the purchaser, and be paramount to every other consideration, are the lives of the people on board. It therefore becomes one of the first duties of the underwriters to see that all ships, in which they are concerned, are properly found in their ground tackling; that they have their proper number of anchors on board, and that those anchors are of proportionate weight to the tonnage of the vessels. It likewise behoves all persons concerned in shipping to know, that there is no article so treacherous in appearance as iron; in proof of which, it must be well known to many, that an anchor manufactured of iron of the worst quality, may be made to look as fair to the eye as one made of the best. I have known an anchor of 70 cwt. to break in two by being lowered quickly from a crane, when only three feet from the ground; and I saw the same thing occur to another, whilst swinging from the wharf, by striking against the side of the lighter on board of which it was intended to have been shipped. It is not at all uncommon for anchors to break when let go *amain*, to anchor the ship, by falling on hard ground, or a rock, as must be too well known to every seaman, which could not have happened if the anchors had been properly manufactured of good iron. An effect so extra-

ordinary as this, and so frequently happening under slight shocks, must have a cause: 1st, it might be occasioned by using bad iron: 2nd, the best iron, if improperly wrought in large bodies, is liable to become brittle. Iron, as before mentioned, when formed round by a hammer of insufficient weight to overcome the *vis inertiæ*, in the resisting medium, will only extend the surface, and compress the arch, without affecting the centre, which, being left at rest, causes the iron, in cooling, to contract irregularly throughout the body, and for want of proper nealing to restore the equilibrium, is liable to break on a sudden impulse. In other anchors of similar construction, where no visible defects appear, reliance is placed on their strength; but when the hour of need arrives, the imperfection is fatally discovered, and at a time when it cannot be remedied. Thus, what ougtht to be the sailor's chief hope and protection, suddenly and unhappily ceases to render its important aid. In this flattering exterior of safety consists the chief peril of our Naval service, and I am sorry to add, that when ships are lost it seldom happens to be attributed to the right cause. Certain it is, that if anchors were made capable of performing their office in the hour of danger, shipwrecks would be less frequent.

Having described the improper shape and defective manner in which anchors have been

manufactured, it shall be my task to point out, what I trust will be deemed a much better mode. If any suggestion can be offered for improving it, I shall be grateful for the communication.

It has already been mentioned that I was induced to turn my serious attention to this most useful machine, by the general letter of the Commissioners of his Majesty's Navy, of the 18th of November, 1800; and although that letter, circulated as it was to all the Dock-yards, did not particularly belong to my department, I nevertheless thought it my duty to transmit to them my humble ideas on the subject, which I have never lost sight of up to the present moment.*

Instead of forming the shank and arms of my anchor of loose bars, as in those before described, I use wide flat bar iron, laid edgewise to the lines of resistance, being in the direction of the arms, through every part when riding a ship, which gives the general principle. The first part to be formed is the throat, which is done by bringing to-

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* In *plate* No. 1, the anchors of the old and new form are most accurately delineated by the same scale, being of equal weight. On viewing both, and comparing the respective proportions they bear to each other, the reader will be able to judge for himself.

gether short pieces of flat iron, half the depth of the shank, and then welding them back to back, half way up on the shank part; after this the remainder is turned off, on either side, similar to two knees, which form the throats, the flat iron being cut, when in bars, in separate lengths, to make the scarphs, and receive the shank and arms. The truss piece is next put together, consisting of short flat bars, which when properly wrought, are attached to the upper part of the throat pieces, and being joined thereto, form a complete cross, to which the arms and shank are ultimately welded, whereby this part of the anchor is made the strongest, being the direct reverse to the old mode. The shank, being formed of flat bars, is made deeper in the line of resistance than it is thick, preserving the largest dimensions in the *trend*, about one third of the way from the crown, at which place the strain is chiefly thrown, when the anchor is brought into action, and consequently should be fortified accordingly, which in no anchor heretofore has been considered.

The shank being thus formed, is welded by a long scarph to the cross, and not as in the old mode, by a short jumping scarph, than which nothing can be worse. The arms being made of flat iron, similar to the shank, with the palms attached to each, are then

brought on, and properly welded to each arm of the cross, not in a straight line with the palms as customary, but in the form of an arch, keeping the palms to an angle of 52°. 55'. which has the effect of giving to the arms the greatest strength, and of enabling the anchor when in the ground, to relieve itself from it, by easy purchases, as every inch on the lift of the anchor becomes a new *fulcrum*. It also causes the anchor to gather itself deeper and deeper into the ground, as the strain opposed to it becomes greater, until it has obtained so strong a holding as to be immoveable. If a hook for catching fish were made similar to an English anchor, it would not perform its office—give it but a little curve, its principle in holding will be then precisely that which the arched anchor possesses.—Moreover, on the old plan, the anchor is raised at one effort, or the arm must be torn off, owing to its being formed straight; which improvident shape, as I have before mentioned, has a constant tendency to throw the anchor out of the ground, in a heavy sea, and has been the cause of many anchors being broken when their assistance was most needed. The short-sighted habit, of leaving sharp edges in the palms, or other parts of the anchor, by which the cable suffers so much in foul anchor, cannot be reproved too much.

It had been the custom with anchor-smiths to work the iron to a keen edge; which thoughtless principle has caused the destruction of numberless cables, ships, cargoes, and lives. Although it may be esteemed by some of trifling import, yet, in my humble opinion, no alteration can be more essential; and all anchors, on the old plan, should be thus altered, as opportunities offer---and none be again issued to a ship unless the edges be first taken off.

The diameter of the ring of the anchor should not be more than sufficient to contain the cable when rounded, and with room to pass the cat-hook. Every excess beyond what is absolutely necessary for that purpose, only tends to weaken it.

The rings of all anchors, above 20 cwt. would be stronger if made of an oval form, flattened at the ends, which should be wrought a little larger, to allow for wear, and increase the strength; but where a chain cable is intended to be used, the ring must be stayed in a central position, (as would be the case in the puddening of it); or a round ring, or shackle, be adopted. The oval ring, when prevented from a transverse strain, is very strong, and allows sufficient room for catting the anchor.

The following are the dimensions of an anchor of 73 cwt. by which I have formed a schedule of proportions, for all sized anchors in the British navy. I sent the table to the Navy Board, for the approval of the Commissioners, in May, 1816, and it was returned approved in August following. Having made this anchor as perfect, according to my plan, as it could be formed, I fixed it as my basis, and from thence reduced the anchors of other dimensions, commencing with that of 95, and descending to 1 cwt.

	Shank														square			
weight	length		size of throat		increase or swell: distance from arm		increase or swell: size		size: trend		size: small		length		size to nut	
cwt.	ft.	in.	in.	in.	ft.	in.	in.	in.	in.	in.	in.	in.	ft.	in.	in.	in.
73	17	4½	11⅛	8⅞	3	1	11½	8⅝	11⅛	8¼	8⅞	6⅞	3	3½	8⅞	7

ring							arms							palms			
hole from end	length from out to out				size: ends	size: sides	length		distance from shank	size: throat		size: small		length and breadth		thickness: close to blade	thickness: edge
in.	ft.	in.	ft.	in.	in.	in.	ft.	in.	in.	in.	in.	in.	in.	ft.	in.	in.	in.
6¼	2	11¾	2	7¾	4½	4¼	5	11⅝	5¼	11¾	8⅞	9¾	7¼	3	0¾	2⅝	2

The principle on which this anchor is made I do not think can be improved; nor am I

[illegible]

[illegible]

aware that its proportions are deficient in any respect. If any part of an anchor be discovered to be weak, the other parts must be reduced in proportion; and the quantity of iron taken therefrom be apportioned to the weaker place, which is the only mode of affording to all parts an equalized ratio of strength. The manner in which the iron of this anchor is brought together, being in flat bars, to the depth of the shank and arms, and laid edgewise to the line of resistance, ensures a superiority over every other plan of construction heretofore practiced. Its component parts are so peculiarly combined, as to prevent workmen, *however careless or indifferent*, from making a weak anchor, although it may be rough and badly manufactured. In every instance where this anchor has been opposed to another, to ascertain its strength, its superiority has been invariably and decidedly conspicuous. The chief care necessary to be observed by the smith, in the manufacture of the anchor, is in welding the scarphs.— The parts about to be connected should be properly slung to the crane, and tried on the anvil, before they are put into the fire, that no delay may be occasioned after the iron is brought to a welding heat; to this point the experience of the fireman is always directed, to prevent the waste of iron, by its being partially heated, and to take especial

but why have any?

care that it be not taken out of the furnace until heated to a proper welding state, at which crisis it ought to be carefully and expeditiously laid on the anvil, and the parts struck by a blow, equal in proportion to the resisting medium, by the Hercules used in the smithery, or a heavy hammer wrought by machinery. The shank and arms of all anchors should be thus consolidated in their first formation; and the method of working them, in our Dock-yards, by the sledge hammers, should not be resorted to, until the iron be first consolidated by a greater power: the sledge hammer may then be used to fashion the work.

The anchor, when finished, should undergo the process of nealing, and this is equally proper in all iron work. The blow of the hammer on the surface has always a tendency to condense the pores of the iron, and destroy its ductility: to restore an equiformity, it should be heated to a dark red, and let cool gradually. Many anchors, for want of this process, have broke, and particularly in our Dock-yards, the smith being too fond of finishing his work by polishing the surface with the hammer.

If the observations here introduced be attended to, and the anchor manufactured with iron of the first quality, and ac-

cording to the proportions given in the table, it will be a rare instance to hear of an anchor giving way; indeed, I may venture to say, that such an occurrence cannot take place. Those that have been put to the test have invariably parted both the chain and hemp cable.

An anchor of light weight, although overpowered, ought only to bend---should it break, the iron must be of bad quality; but a large anchor of 30 cwt. and upwards, cannot be expected to bend, for the following reasons: when brought into action, having strong hold in the ground, it is subject throughout to a transverse strain, and being formed much more in depth than in thickness, must ever maintain a superiority in strength over a round shank, or those of the foreign shape, which are nearly square. The area of the fracture would take place in the part of least resistance. In whatever part of the fracture the *neutral axis* may be, it will be considerably above the centre, and the fibres below will be in a state of tension, whilst those above are in a state of compression; the former being removed so far from the neutral point, and no longer capable of sustaining the increased tension, will break---which, in a less body of the same iron, would only break. It is, therefore, obvious, that the arms of a small anchor might be drawn almost straight, while

those of a larger would break. In determining the angle that the arms of the anchor should bear to the shank, I consulted the most experienced seamen, and upon their opinions, I fixed it to the angle of 52° 55′, being the same that had before been in practice, and already described.*

The French, Spanish, Dutch, and some English anchors, have been manufactured of small flat bars, placed indiscriminately in the shank and arms; in some laid flat to the line of tension—in others edgewise, and partaking also of both, being weakly cemented in the crown. The greater part of the foreign anchors, tried in the smitheries of the Dockyards, at this and other ports, have failed; all that have fallen to pieces, as well as those untried, have been ordered to be sold or remanufactured: they are, in general, wanting in proportion, badly wrought, and not to be depended on.

* The anchor represented in *plate* No. 3, is constructed on a similar principle to that I have been describing; the only difference being in the formation of the truss, which is extended beyond the crown so far, as to enable the arm, when in the ground, to receive support from that which is out. It may be deemed as strong an anchor as can be formed: how it might answer I cannot say, as none has been made for trial. Grapnels made after this plan, with additional flukes, would be very strong.

In April, 1813, the first anchor constructed on my principle, was ordered by the Navy Board to be made in Plymouth yard, and tried by the officers of the yard, against one of equal weight on the old principle. It weighed 24 cwt. 1qr. 3lb. and on trial obtained a superiority far beyond my anticipations. The anchors opposed to it were the best the master-smith of the Dock-yard could select from the whole in store, but my anchor broke one of 24 cwt. 1qr. 18lb.; another of 24 cwt. 2qrs. 7lb; another of 29 cwt. 2qrs. 3lb; and another of 35 cwt. 1qr. 17lb. This manifest superiority of strength, however, was not thought sufficient, and trials of a different description were resorted to, by making anchors of various weights, and sending them to sea to be tried, and reported on, by the respective Commanders. The ships which received them were the Menelaus, Vengeur, York, and Impregnable, whose Captains and Officers made the most satisfactory reports to the Navy Board; and, in consequence, the Board thought it right to order a second trial of strength to take place. The report from the Menelaus has already been given, in a letter from Captain Dix; the others were very similar.

The master-smith of Deptford Dock-yard was afterwards selected to make the best anchor he was able, of 26 cwt. for the pur-

pose of opposing one made under my inspection at Plymouth, weighing 25 cwt. 2 qrs. Both anchors were sent to Chatham Dock-yard to be tried, under the immediate direction of Commissioner Sir Robert Barlow; the trial took place on the 11th of April, 1815, when my anchor broke the one opposed to it with the utmost ease.

The Commissioners of the Navy, still wanting further proof, directed an anchor of larger dimensions to be tried against mine of 25 cwt. One of 31 cwt. was selected, which, after bending considerably in the shank, under a very heavy strain, broke in the arm, whilst my anchor did not *in the least* alter its shape. Sir Robert Barlow, in his letter to the Navy Board of the 26th of March, 1815, writes, "and I have to add my "opinion, that the very great superiority "of Mr. Pering's anchor is owing to its "exterior form, and the true mechanical "principles on which the component parts "are formed and combined."

After these trials, and the favourable reports from the Naval Commanders, the master-smiths of the different Dock-yards were ordered, by warrant of the 4th of December, 1815, to attend at Plymouth, to be instructed, under my superintendence, in the new mode of making and repairing

anchors. An anchor of 73 cwt. was made, and one of 45 cwt. was repaired, on my principle. They expressed themselves much satisfied with the plan, and signed a certificate, previously to their taking leave for their respective Dock-yards, stating, that it was much superior in strength to those made by the former mode, both in principle and form. Since that time, hundreds of anchors have been made on the same plan, and I have not yet heard that one anchor has broken, suffered the ship to drive, or failed in any respect in the performance of its office.

In July, 1815, Mr. WHIDBEY, Superintendent of the works of the Breakwater in Plymouth Sound, complained to the Navy Board that the anchors he had in use were continually breaking, and requested he might be allowed those made on my principle. Thirty-nine anchors were made accordingly, not one of which has broken, although twenty-eight of those on the old construction have entirely failed.

Having thus produced sufficient testimony of the superior strength and shape of these anchors over the others heretofore in use, I shall offer a few remarks as to economy in their manufacture.

Anchors made on this principle, will not only be the strongest, but waste less iron in

workmanship, and therefore are made at a less expence. In making a 74 gun ship's anchor after the former plan, the iron lost in the fire by melting, chipping, cutting with the chisel, and oxidation when on the anvil, amounted, on an average, to forty per cent.— An anchor on the present plan, of similar dimensions, loses only twenty-nine per cent. which was the precise waste on the anchor of 73 cwt. made in the presence of the master-smiths of the different Dock-yards. The smiths in the habit of making the new anchors, can perform their work in rather less time, and with considerably more ease, than by the former plan.

In all cases, as before-mentioned, good iron should be used; and when an anchor is finished, it ought to be properly nealed, which should be the last process with all iron work.

That no country should have given this important instrument due consideration, for such a length of time, is much to be deplored on many accounts, since consideration must have led the way to some improvement; and we should have witnessed, in the anchors made by various nations, a more perfect shape, and better defined proportions, with the arms and shank very differently wrought in the crown. In this part the French, Dutch,

Swedes, Russians, and Spaniards, form the throats of their anchors into a sharp angle, *than which nothing can be worse;* yet their anchors possess a superiority over those of our old make, by the curved form of the arms, which the maritime greatness of the English nation ought long ago to have seen the propriety of adopting. The angle of the palm, with respect to the shank, in the foreign anchor, is generally too great, being about 55 or 56 degrees, which prevents it from gathering into the ground as quickly as it ought to do when the anchor is cast, and renders it more liable to be torn off in weighing. The large anchors of all foreign nations, which have fallen under my observation, are deficient in proportion, and should not be trusted to in a storm; but the small anchors of the Dutch appear to be better wrought.

I have been thus particular in my explanation of the anchor, because I have never met with, nor heard of, any treatise, that has entered immediately into the subject; and likewise consider it deserving of the highest attention, as the safeguard of life, and the protection of property.

Seven anchors are allowed to each line of battle ship—one sheet, three bower, two kedge, and one stream. The sheet and bower anchors are those on which the ship chiefly

depends: the other three are considerably smaller. Frigates take six anchors, and sloops only five.---The value of a large anchor for a first rate is £470; and twenty men are occupied thirty days in making it.*

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* It may not prove uninteresting to the anchor-smith, to know the process by which iron is reduced from its original into a malleable state; with which if not previously acquainted, he may find, in reading these observations, some useful remarks connected with the working of iron in the formation of anchors.

Iron is the most useful and abundant of all the metals. It mixes alike with the animal, vegetable, and mineral kingdoms; and civilization depends so much on its discovery, that we should have made but little progress from a savage state, without the aid of the blacksmith. A great part of the civilized employments of man consists in the working of iron; without it agriculture would be almost at a stand, and its implements inefficient: wood could not be wrought—no other metal would admit of so keen an edge—nor could the earth be so easily opened in search of its hidden treasures. It is said to be of more intrinsic worth, when manufactured into the hair-spring of a watch, than an equal quantity of gold manufactured to its greatest extent.

Iron ore is collected from the hills of Yorkshire, Cumberland, Wales, and other parts of Great Britain, and found in almost every part of the globe. It is formed into malleable iron by being first roasted with cinders, for three days, in the open air, to expel the sulphurous arsenical parts; and afterwards taken to the furnaces, which are commonly made of a conical form, from forty to fifty feet high. The furnace is charged at the top with ore, and equal parts of coal cinder, or

It is to be hoped, after the foregoing observations, that the mercantile and shipping interest of the kingdom will no longer endanger their property, and the lives of British

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coke, and lime-stone, to act as a flux. The fire being lighted at the bottom, the heat is excited by means of bellows, and the ore melting as it passes through the fire, is received at the bottom, where it is maintained in a liquid state, until a sufficient quantity be collected, which usually happens every eight hours; it is then let off into moulds, to be formed for the purposes intended, such as cannon or pig-iron, &c. being as yet in a crude state. The process of refining crude iron varies in different places. The operation consists in destroying the combustible matter which it holds in solution, and giving to it a fibrous texture. When taken to the refinery and melted, it is let out of the fire to discharge the *scoriæ*, and then returned, and subjected to the blast as before; which operation is repeated until it acquire a fibrous consistency: the iron is then taken out of the refinery, and beaten, to rid it of extraneous matter; again returned, taken to the forge-hammer, and beaten gently, until it obtain a proper tenacity, leaving it a little larger at either end. In this form it is called *ancony*. It is now taken to the fire, called a chafery, made of common coal, and the two ends being drawn out into the form of the middle, the operation is finished. Other methods are practised by a reverberating furnace, the iron passing while hot, between metal rollers of different capacities, which operate like the forge-hammer, by depriving the iron of its impurity.—When iron has been completely freed from carbon, and acquired its highest degree of malleability by repeated hammerings, it becomes the most tenacious of all

seamen, by making use of an inferior anchor, when one of superior strength may be obtained at an equal, or even a lower, rate.

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metals; but if kept in red heat for any length of time, it is liable to get brittle. It is not an uncommon practice for smiths to leave the iron in the fire all night, in order to save time in the morning; this practice, for the above reason, ought to be discontinued. Nothing more is necessary to impregnate the bars of iron with carbon, by which they become steel, than to stratify them with powdered charcoal, in a close vessel, and expose them to a degree of heat, a little short of what would fuse the metal, for a proper length of time, until the bars become blistered, which generally takes place in about eight days, when it is called blistered steel. German or shear steel is made by breaking the bars of blistered steel into small pieces, and re-working them under a forge hammer. Cast steel is made from the blistered steel; the bars being first broken and put into a crucible, with a flux, and fused, the metal is cast into ingots, and then called ingot steel; but when it undergoes tilting, its texture is the most complete, and is called tilted steel. The process of case-hardening is known to almost every smith, and is no more than a quick method of changing the surface of the iron into steel, by inclosing the article in an iron case, stratified with animal carbon, or the parings of a horse's hoof, and salt. When heated red-hot in the forge, the salt fuses upon the surface, and prevents it from oxidizing; it is then quenched in the water and brushed clean. I do not deem it necessary to enter more into the process of making malleable iron or steel; it is sufficient to shew that iron may be injured in its ductility, by being permitted to remain too long heated.

My sole aim in publishing this treatise is from a desire to be useful; and if my ideas and the arguments I have adduced be just, I hope they will be adopted, and not be merely read and then forgotten; for if duly weighed, in all their bearings, the most beneficial results may be anticipated.

With respect to merchant ships, I would suggest an expedient for their better security. Ships of this description generally sail with anchors and cables made as light as possible, in order that the crews, being generally few in number, may have less trouble in weighing anchor or working the ship. Whenever, therefore, a vessel happens to be imbayed, with the wind direct on shore, and her sails perhaps shattered, she has no other resource but in her anchors and cables; and these perhaps not being of sufficient weight, the loss of the ship and cargo, and the destruction of her crew, must be the inevitable consequence. To prevent such too frequent disasters, I would strongly recommend to all ship-owners, and to Government for small ships, to provide their vessels with an anchor and cable of larger dimensions, (in lieu of the sheet anchor) called *a storm anchor and cable, (anchoram sacram solvere)* to be let go only on dangerous occasions. As all merchant ships, or ships of small tonnage belonging to his Majesty, having on board

three anchors of full size, viz. a sheet and two bowers, consider themselves well provided, I would recommend the former to be larger than either of the latter two, according to the annexed table, in forming of which I have been governed by the best experienced opinions I could collect, from the most able seamen, and also from the weights of the anchors, appropriated to the different class of ships in his Majesty's Navy. In the smaller vessels, it will be observed, I have increased the weight a little more, in proportion to the tonnage of the ship, than at present allowed, confining myself to a graduated rate, according to the tonnage that one ship should bear to another. Never having met with a table of the same sort, I am flattered in thinking it will be found of much use in the mercantile world. Should the weights of the various anchors, which I have respectively appropriated to the tonnage of each class of vessel, be considered either too high or too low, such may be used as are most approved of, according to the table. In this I mean not to dictate, but only to offer my humble opinion. It is very natural for the Commander of a vessel, to wish his anchors as light as possible, for the sake of convenience; but when the storm arises, the vessel, if anchored in a light soil, must drag; and it is at this dangerous crisis that he finds his anchors unequal to the contending impetus.

With respect to the table of the dimensions of the anchors, I beg to assure my readers it was a task of no trifling undertaking, having no data from whence to form my proportions; and it afforded me great satisfaction to have it returned from the Navy Board, approved, without an alteration.

As the weight of the anchor increases, in proportion as the tonnage of the vessel becomes less, so should also the weight of the storm anchor be increased, in proportion to the weight of the bower, which ought to be more in a small vessel than in a ship of greater tonnage. It should also be bent to a cable of proportionate size, whether it be of hemp or iron; if the latter, it would be less liable to injury when on board ship, or to be cut by the rocks in foul ground. It is for the experienced seaman to determine which cable should be preferred: the former is well known—the latter I shall speak of more as I proceed.

This cable should be kept constantly bent to the storm anchor, and always ready to be let go when required, though it will be only wanted in a storm. The two others, being used as the working anchors, answer all common purposes. Such preventive measures as I now recommend, aided by the two bowers, will enable the ship to ride out almost any storm to which she can be exposed. At

the same time, however, it must not be supposed that I deem it impossible for a ship to be wrecked thus provided; all I would say is, that many might be saved, particularly when riding in the Downs, together with their seamen and treasure, if the simple means before suggested were but properly and timely used.—Storms sometimes rage so violently as to set at nought all the art and courage of man, and render them of no avail; but surely there is a degree of solace in the reflection, that in such perilous trials, every means which human ingenuity and prudence could devise, has been exerted to withstand their effects.

Candour enjoins me now, to call the reader's attention to two points, which may rather militate, in the opinion of some, against my recommendation. The first is, the additional expence that must be incurred, in furnishing an anchor and cable larger than those commonly used;—the second, the additional trouble which may be occasioned, by working an anchor so much larger, perhaps, than the number of hands on board a merchant ship can conveniently manage. On the first point I would observe, that where ships and valuable cargoes are at stake, every parsimonious idea should be discarded. And as to the second, since it is only in a storm that the storm anchor will be wanted, I should hope there is not a British seaman who

would decline using his best energies, when he knows that by such exertion he will promote his own safety, and the interest of those whom he serves. The difference in point of weight is trifling—its consequence very great.

It is to the ship-owners and underwriters of this kingdom, that I particularly address myself, as the parties most interested; for whether a ship be insured to her full value or not, the consequence of her loss must affect the one or the other; but what stands paramount to every other consideration is, the saving of life, at which, though it be only in a solitary instance, humanity must ever rejoice.

The anchor-stock must also be considered; for without it the anchor cannot be complete, nor perform its office. In large anchors, the stock is always made of wood, but in those of small dimensions, it is frequently made of iron, principally for the convenience of being more easily detached from the shank, and for stowage to the bows of the ship. The anchor being *cast*, and finding bottom, will meet the ground with the flukes, either vertically or horizontally; if in the latter position, and the vessel have way, the flukes ought instantly to be thrown vertically by the stock; the under one entering the ground,

is thereby retained, and holds fast the ship. The dimensions to be observed in forming the anchor-stock are—the length of the stock to be the length of the shank, and half the length of the ring—to be square in the middle, one inch to a foot, and to taper at either end, to half the diameter of the middle. In order to secure the stock better to the shank, I would recommend, that all anchor-stocks above 20 cwt. have a piece of plate-iron fastened to the sides, and fitted to the score, to prevent the anchor from twisting and splitting the wood, technically called *gimbleting*; and also to create additional strength. An anchor-stock may be converted from two pieces of plank, (bent to their shape from the kiln) with small wood chocks fastened thereto, forming the score to receive the shank of the anchor; by which conversion much valuable timber might be saved, and the strength of the stock increased.

The stock, when attached to the shank, and brought together in two parts, should be bolted and strongly hooped, collapsing the shank very tight; and the edges of the hoops should invariably be beaten down, to prevent their cutting the cable when it gets underneath the stock, which is very common when the ship is laying at single anchor. In the few made under my direction, I have paid particular attention to this point, and most

strongly recommend it, though I have seen it in no other instance. The value of a cable is very great, and to preserve it from injury is of much consequence: numbers have been destroyed for want of this precaution. In stocks of small dimensions, four hoops are enough, but in those of larger size six are not too many. I cannot call to my recollection a piece of timber cut more to waste, in conversion, than an anchor-stock. The quantity consumed throughout the navy, for this purpose only, is very considerable.

Inferior timber may be used for almost every part of a ship rather than for the anchor-stock, which should be made of prime wood, and not as I have often observed, converted from a shaky or knotty log, the safety of the vessel frequently depending on its efficiency.

The fleet, when off Basque Roads, under the command of Admiral Lord GAMBIER, carried away so many anchor-stocks, that every spare one throughout the squadron was used. It must be considered that without the stock the anchor is of no use; it is that which first brings it into action, enables it to maintain its station after the anchor has been canted to its proper position, and causes the fluke to enter the ground on the drag of the ship.

The quantity of timber necessary to form an anchor-stock for a first rate or 74, is 80 feet; and to new stock the anchors of the British navy, including spare ones for each sea-going ship, would consume about 4,000 loads, amounting to £36,000. The value of the whole of the anchors in the navy, including stocking and workmanship complete, is about £520,000. Large as these sums may appear, they are nothing compared to the intrinsic value of oak, the scarcity of which is such as to demand the strictest economy. This will not be properly attested until the commencement of another war, when the demand for it will be in proportion to the exigency of the times; the price of oak, from its scarcity, not having fallen since the peace. The various woods of English growth are, individually, more adapted to particular purposes; and oak particularly so for that of an anchor-stock, as it combines both strength and durability. To accomplish this end I have so contrived the stock before noticed, (as represented in plate No. 3) that with a little more labour, it can be economically converted, with a saving of nearly one-third of the timber now used for the purpose.

It might be imagined that when the navy of England was once furnished with anchors, their wear and tear would not be great: with

respect to the anchors alone, if they had been properly manufactured, the wear on them would be comparatively trifling; but the stocking part will always be considerable. The loss of anchors by parting the cable, ships foundering, and being wrecked, will cause the necessity of a constant supply.

Iron stocks are only used for small anchors, being more convenient, and stowing better to the bows of the vessel; for which purpose the stock should be formed flat, equal in size to the small of the shank of the anchor, and made tapering, with a turn at either end, as represented in Plate No. 2, to prevent its being detached from the shank and lost; and to keep it from entering the ground on being dragged, when about to turn the anchor; which operation, if not instantly effected, would most likely either break or bend it; but if the iron stock be turned at the ends, and the anchor dragged to any distance before the purpose of tripping is effected, it would be less liable to injury, as the turned end will cause it to travel upon the surface of the ground, till the anchor cants; and would still perform the operation quicker, if the turned ends were thrown laterally from the direct line of the shank. It should also have a stay, passing diagonally from the outer part of the stock to the point, forming an eye, to prevent hooking any part of the

rigging, as represented in Plate No. 2, instead of the large knob, or the tapered point, at present used. The iron anchor-stock is a very bad substitute for wood: though much may be said against it, nothing but the plea of convenience can be adduced in its favour. In the merchant service they are not much used; but in his Majesty's service are frequently applied to anchors as high as 14 cwt.; it might be better if they were not used to any exceeding 5 cwt. The iron stock may be so contrived, as to be shipped or unshipped from the anchor at pleasure, by flattening the knob at the turned end which passes through the shank of the anchor, to the form of the hole in the shank. The stock being turned to a right angle will then relieve itself. This easy contrivance has been lately introduced by Mr. Brown, Master-Attendant of Woolwich Dock-yard.

It is indispensably necessary that all ships be well found in their ground tackling, of which the anchor constitutes but a part, the cable bearing the other proportion; the latter has of late years been manufactured of iron, and introduced into his Majesty's navy, for the use of small ships; on which I beg to offer a few remarks, principally as to the mode of proving the chain cable.

The greatest strength of cohesion in malleable iron, when manufactured into chain

cables, is the most to be desired; but is not to be obtained, unless made of iron of the first quality. A square bolt of good Welch iron 12 feet long, and 2 inches in diameter, ought to bear a strain of 82 tons to tear it asunder. Notwithstanding the tension good iron will sustain, its liability to injury during the process of manufacture, is too well known to exist, and ought to be watched with a suspicious eye.

Iron may be injured by too much hammering, from improper and carbonizing heats, and many other incidental causes; it may also be deprived of its tenacity from extreme cold. Iron when manufactured into a chain, from the bolt, will lose a considerable portion of its strength, the necessary form of the link breaking the direct line of tension; and the welding of each, destroying that continuity of fibre it had received by the process of forming it into bolt iron. The round-faced hammer of the smith likewise causes an irregular indentation in the fibre, and by condensing its pores, destroys its ductility. Iron, when drawn under the compression of rollers, may be compared to hemp, or any such fibrous substance: as rope is strongest when the fibre of the hemp has but little twist, and is kept nearest to the direct line of tension, namely, that of a *salvagee*, so is iron when drawn into wire. I cannot more

strongly exemplify the injury bolt iron is subjected to by the hammer, than by remarking, that it was customary, some years since, for all bolt iron to be delivered into his Majesty's Dock-yards square, to be afterwards rounded by the smiths at the forge. In repairing the shipping at that time, the bolts were frequently found broken by the working of the ship, at the rate of twenty to one of the present period; nor was it at all uncommon for a bolt to break in driving.

Chain cables are manufactured in various parts of the kingdom, but previously to being used, they should undergo a severe test of strength. At Captain BROWN's iron cable manufactory, Mill Wall, Poplar, is a machine for this purpose, which acts on the principle of a weigh-bridge; and at Messrs. BRUNTON and Co.'s manufactory, at Lime-house, the chain cables are tried by an hydrostatic machine, or Bramah press; but in both machines the trial is made by short lengths, consequently the process is very tedious.

Before a chain cable be bent to the anchor, it ought to have undergone proper proof; but the purchaser possessing no means of his own to attest it, is obliged to rely on the *ipse dixit* of the manufacturer. Such is the case with the chain cable for the use of his Majesty's navy; I would therefore recommend its being

tried, not in the manner beforementioned, but at whole length, by a machine erected for the purpose, on a solid foundation, in one of his Majesty's Dock-yards, under the immediate superintendence of the proper officers; this might be done in a manner at once simple and economical, by confining either end to the rock, and thus avoiding the necessity of any intermediate frame to sustain the tension.

My reasons for this recommendation are, that it will set aside all doubt as to the proper attested strength of the chain cable, and clearly evince, on the cable subsequently parting, that it must be owing to a *kink* in the chain, a sudden jerk, or some incidental cause, which would not have taken place under a direct and steady impulse. As a ship when anchored rides at the whole length of her cable, it should be put to the proof in the same manner, which would be far better than trying it by a few fathoms at a time. The demand for chain cables in time of war, if generally used by small vessels, would be very considerable: implicit trust, therefore, placed in any one person, particularly the manufacturer, is liable to abuse.

Various chains are served into his Majesty's Dock-yards, which undergo no other trial than being promiscuously struck by a

hammer; if the link resist the blow without breaking, it is taken for granted that the whole chain is good. The top, cross jack, shank painter, anchor stoppers, chain, &c. should be separately proved, similar to the chain cable. It is further to be considered, that cables, although made of iron, will wear, particularly in the part nearest the anchor, which being constantly on the ground is subject to much friction; when thus weakened, and reduced by oxidation, it will be necessary again to prove them. It is not enough to say that if the chain cable break when riding the vessel, it should be replaced by the manufacturer, without any additional expence to Government, or the merchant—the immediate consequence that may attend the parting of a cable cannot be requited, as the loss of the ship, and all on board, may be the fatal result. Had the smiths paid proper attention to the manufacture of anchors, or had the value of my recommendations herein explained been earlier understood, the navy had not been filled with such inferior anchors as it now possesses. In a case of so much vital importance as the saving of life, it might be advisable that chain cables for the use of his Majesty's navy be manufactured in his Majesty's Dock-yards, and severally tried before issued to a man of war.

Nothing but necessity should admit of an anchor or iron cable being manufactured,

but under the immediate inspection of a proper officer. The scarphs on each link should invariably be made long; and to effect this properly, with the least trouble, they should be welded, not in the ends, as is too commonly the practice, but in the side, before the link be properly formed, under a long scarph, and by two heats at least. It may afterwards be moulded to any shape, and the scarph placed laterally, which in the purchase of chain should be particularly stipulated. This plan being followed, the chain, if made of tough iron, will not part, unless overpowered beyond its standard weight. The chain cable has some advantages over that of hemp, yet its disadvantages are many; and whilst these exist, the latter must maintain the superiority. The treachery of iron is proverbial, and the chain which holds to-day may break to-morrow with half the strain; it being subject to atmospheric changes, to kinks, twists, sudden jerks and nips, inefficient workmanship, improper hammering, inferior iron, and inadequate and carbonizing heats; either of which, if suffered to exist in any link throughout the chain, reduces the whole to the strength only of that identical part. It is, also, less manageable than a hemp cable, more dangerous to use, and difficult to handle.

Moreover, it is to be observed, that a chain is a series of connected links, separately in-

flexible, and when thrown from a straight line will form as many angles to the length of each separate link. The larger the chain the longer must each link be formed, and, in proportion to their increased length, so will it diminish in strength. When bitted, and passing through the hawse-hole, the link will frequently extend beyond its bearing point, forming a fulcrum, and a lever thereon, in proportion to its extension. These will always create an insuperable objection to iron cables, when compared with those of hemp, and ever render them more uncertain in performing their office.

When a ship is at anchor, and riding in a heavy sea by chain cables, each wave, by its undulating motion in passing under the ship, assisted by the weight of her cables, will cause her to be forced a-head against the wind so far as to prevent the vessel resuming her proper position before the succeeding wave strikes the bows; the ship, receding, will not always retire in a direct line, but slue herself round almost broadside, and in recovering her proper position, will be brought up with a severe surge; and unless it were possible to buoy up the chain from the bows of the ship to the anchor, I fear there will be no means of preventing this evil, so much to be dreaded in time of extreme danger. These are the disadvantages apper-

taining to chain cables, from whence proceeds the cause of their repeatedly parting; and unless by any future process they can be obviated, the chain cable will ever remain an uncertain stay to the ship in a storm. At the same time, as I have before observed, they are less liable to injury on a long voyage, when on board the vessel; and in foul ground, the advantage they possess is obvious.

Although a chain has been in common use, and applied to various purposes for ages past, I have never understood that it afforded a substitute for hemp, as applied at present, until made so by Captain BROWN. When I first saw a chain cable I took a lively interest in its success, and although personally unacquainted with the projector of the plan, I submitted to him some remarks on it, which I thought conducive to its benefit, and these were promptly and kindly acknowledged.—Since the application of a chain to stay the ship, several improvements have been progressively introduced, yet there is still room for many more, to obviate, if possible, the objections before enumerated. One I beg leave to offer is, that of making the links of large chain cables shorter than they are at present.—In submitting this improvement, I am aware that the trouble in manufacture will be greater, and the original cost advanced; notwithstanding which, it is indispensably

necessary that every suggestion that acts as an auxiliary should be adopted, as affording more completely the means of effecting its purpose.

The shorter the links, the stronger will the chain be, beside allowing it to ride easier, and deliver itself with more facility over the bits and hawse-hole; thereby easing the nip, which must in a greater or less degree take place in a protruded link, and enabling it to sustain the vessel in a storm, when a chain of equal sized iron, with longer links, would part.—The length of the links of a chain cable, apportioned in strength to one of hemp of 18½ inches, is from 10½ or 11 inches to 7 and 6½ wide; and although these are much shorter than they originally were, they might be still further reduced. The shape of the link at present is nearly that of a lozenge, but if the lateral parts of each were closed, so as to form nearly parallel lines, it would be much stronger. As a proof of this, I would suppose a chain to be formed of round links of the most ductile iron, and without a transverse stay to each, as now placed: the chain being submitted to a strong tension, will reduce every link to parallel lines, so that the nearer it can be originally formed to this shape, the stronger it will become. As a more convincing proof of this, let a chain be made of lead and submitted to

a strain, and every link will form itself to the shape into which it ought to have been first wrought; and if put to the utmost stretch the sides will close laterally upon each other, forming a hollow line on either side. I am inclined to suppose that a chain cable, having short and parallel links, would need no transverse stays; and thus a very great point would be gained by a considerable reduction of its weight. The stay forms a compartment for each succeeding link, which, being shaped in the form of a lozenge, would be liable to *ride* without it, and deliver itself foul; but in the form suggested, this would not be the case, as the two links within the connecting one could not pass each other; but, on being thrown loosely together, would touch in the centre, instead of, as they would otherwise do, against the transverse stay. Should chain cables be hereafter manufactured in the Dock-yards, I hope to see a proper trial on this principle, as it would lessen, in a great degree, the agitation at present occasioned to the ship when the anchor is let go *amain.*—After a proper trial has been made, if the result prove the necessity of continuing the transverse stay, no reason can be offered why the size of it should not be considerably reduced. As it now stands, the strength of the cable is in a certain degree lost, by the unnecessary weight it has to sustain; and the price of the cable increased, whilst the in-

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trinsic value is lessened. The transverse stay is the only part of a chain cable made of cast iron. All unnecessary weight should be avoided, that the bows of the vessel may be lightened as much as possible to prevent her plunging too deep into a heavy head-sea. The cable might then with more facility be handled and managed by the seamen, and more easily wrought and transported. In fact, the lessening the weight of a cable without reducing its strength, is an object so desirable, that, I should hope, it need only be known to be carried into effect.

As a proof of these observations, I have to remark, that chain cables of equal power vary considerably in weight: one now in store in the Dock-yard, of $1\frac{7}{8}$ inch iron, equal to a hemp cable of $18\frac{1}{2}$, of 100 fathoms, weighs 178 cwt. 3 qrs. 14lb.; whilst the weight of another is 161 cwt. 21lb, making a difference of 17 cwt. 2 qrs. 21lb.

There can be no reason why one cable should exceed the other so much in weight, as long as the wrought iron they contain is of equal size. If sold by weight, at an equal rate, the former must exceed the latter in price, in as much as it is heavier; and the purchaser will be buying *cast* iron at the price of *wrought*. If, on the contrary, they be sold ℔ cable, the additional weight in the heavy

cable is a waste of materials, which can only be a burthen to the chain, and an impediment to its use. These cables are calculated for large class frigates. It is not for me to say with which cable a ship would more easily ride in a strong gale—the seaman must judge for himself.

The chain cable is open to much improvement; and let us hope, that before the Royal Navy is completely supplied, the means may be found of obviating, in a great measure, the objections before enumerated.

Before I conclude, I shall merely detail a conversation which took place between myself and a master-ropemaker, on the manufacture of a hemp cable, at a port some distance from London. On walking into the rope-ground, I observed to one of the spinners, that the hemp he was using did not appear clean, was badly hatcheled, and not topped. The master of the rope-ground being present, (though at the time unknown to me) replied, that my observations were correct, and that, though sorry for it, he was under the necessity of using inferior materials, because his neighbours did the same; for were he to spin such yarn only as ought to be manufactured into a cable, he should starve; as the cable likely to meet the readiest sale would not be the one made of the purest and strongest hemp, but

that which could be rendered the cheapest. In order to shew that cables are sometimes sold of an inferior quality, I have mentioned the foregoing circumstance, to guard the purchaser, if possible, against imposition, particularly in a cable.

To impress the important contents of this treatise still further on the reader, I will briefly compress them in one view.

1. Let all anchors be made of iron of the best quality.

2. Let the shape of the English anchor be altered in every respect, by abolishing the straight arm, and substituting the arched in its stead.

3. Let the shank and arms be connected without being joined in the crown.

4. Let anchors be made of flat bar iron, placed edgewise to the line of resistance throughout, and not, as heretofore, with square or round bars, faggoted together promiscuously.

5. Let both the shank and the arms be formed flat, in a proper proportion to the line of resistance; and not round, as has been the custom.

6. Let the edges of the palms, and hoops of the stock, and every other part of the anchor, that may be liable to cut or injure the cable in foul anchor, be rounded.

7. Let all merchant vessels, and those of small tonnage, be furnished with a storm anchor and cable, by which much danger will be avoided and the proverb attached to the sheet anchor of the ancients, of *sacram anchoram solvere*, be truly exemplified.

That the principle of the invention of the improved anchor, herein described, might not be infringed on, I deemed it prudent to obtain a Patent to preserve its purity, and having given it much consideration, I am of opinion, that it is not capable of any further improvement.

Had I foreseen the fatigue and inconvenience to which I have been subjected in this undertaking, I am uncertain if my fortitude would have supported me through it. I have been led on, not by insensible degrees to the present moment for the space of nineteen years, but more by the opposition experienced; and, that these suggestions may be more generally known, they are submitted to the public.

A TABLE

OF

Dimensions for Anchors,

ON

The Principle adopted in His Majesty's Navy, graduated from 1 to 95 Cwt. as invented by *Mr. Pering*.

Weight	Shank.												Square			
	Length		Size of Throat		Increase or swell				Size				Length		Size to Nut	
					Distance from arm		Size		Trend		Small					
cwt	ft.	in.	in.	in.	ft.	in.	in.	in.	in.	in.	in.	in	ft.	in.	in.	in.
95	18	7 3/4	12 5/16	9 13/16	3	4	12 3/4	9 5/8	12 5/16	9 3/16	9 11/16	7 7/16	3	9	9 9/16	7 9/16
94	18	7 1/4	12 1/4	9 3/4	3	4	12 11/16	9 9/16	12 1/4	9 1/3	9 11/16	7 7/16	3	8 3/4	9 9/16	7 9/16
93	18	6 3/4	12 1/8	9 3/4	3	3 3/4	12 9/16	9 7/16	12 1/3	9	9 5/8	7 3/8	3	8 1/2	9 1/2	7 1/2
92	18	6 1/4	12 1/16	9 11/16	3	3 1/2	12 1/2	9 3/8	12 1/16	9	9 9/16	7 3/8	3	8 1/4	9 1/2	7 1/2
91	18	5 1/4	12	9 5/8	3	3 1/4	12 7/16	9 5/16	12	8 15/16	9 7/16	7 7/16	3	8	9 7/16	7 7/16
90	18	4 3/4	11 15/16	9 9/16	3	3 1/4	12 3/8	9 1/4	11 13/16	8 7/8	9 7/16	7 5/16	3	7 3/4	9 7/16	7 7/16
89	18	4 1/2	11 7/8	9 1/2	3	3	12 5/16	9 3/16	11 7/8	8 13/16	9 7/16	7 5/16	3	7 1/2	9 3/8	7 7/16
88	18	4 1/4	11 13/16	9 7/16	3	3	12 1/4	9 1/8	11 13/16	8 3/4	9 3/8	7 1/4	3	7 1/4	9 3/8	7 1/8
87	18	3 1/4	11 3/4	9 3/8	3	2 3/4	12 3/16	9 1/8	11 3/4	8 3/4	9 3/8	7 1/4	3	7	9 5/16	7 3/8
86	18	3	11 11/16	9 5/16	3	2 3/4	12 1/8	9 1/8	11 11/16	8 11/16	9 1/4	7 1/4	3	6 3/4	9 5/16	7 3/8
85	18	2 1/4	11 5/8	9 5/16	3	2 1/2	12 1/16	9 1/16	11 5/8	8 5/8	9 5/16	7 1/4	3	6 1/2	9 1/4	7 3/8
84	18	1 1/2	11 9/16	9 1/4	3	2 1/2	11 15/16	9	11 9/16	8 9/16	9 1/4	7 3/16	3	6 1/4	9 1/4	7 5/16
83	18	1 1/4	11 1/2	9 1/4	3	2 1/4	11 7/8	8 15/16	11 1/2	8 9/16	9 3/16	7 1/8	3	6	9 3/16	7 1/4
82	18	0 1/2	11 1/2	9 3/16	3	2 1/4	11 7/8	8 15/16	11 1/2	8 1/2	9 3/16	7 1/8	3	5 3/4	9 3/16	7 1/4
81	17	11 3/4	11 7/16	9 3/16	3	2	11 13/16	8 7/8	11 7/16	8 1/2	9 1/8	7 1/8	3	5 1/2	9 1/8	7 1/4
80	17	10 1/2	11 3/8	9 1/8	3	2	11 3/4	8 7/8	11 3/8	8 7/16	9 1/8	7 1/8	3	5 1/4	9 1/8	7 1/4
79	17	10	11 5/16	9 1/16	3	1 3/4	11 11/16	8 13/16	11 5/16	8 7/16	9 1/16	7 1/16	3	5	9 1/16	7 3/16
78	17	9 1/2	11 1/4	9	3	1 3/4	11 5/8	8 3/4	11 5/16	8 3/8	9	7	3	4 3/4	9 1/16	7 1/8
77	17	8 1/2	11 1/4	9	3	1 1/2	11 3/8	8 3/4	11 1/4	8 3/8	9	7	3	4 1/2	9	7 1/8
76	17	7 1/2	11 3/16	8 15/16	3	1 1/2	11 9/16	8 11/16	11 3/16	8 5/16	8 15/16	6 15/16	3	4 1/4	8 15/16	7 1/16
75	17	6 1/2	11 3/16	8 15/16	3	1 1/4	11 9/16	8 11/16	11 3/16	8 5/16	8 15/16	6 15/16	3	4	8 15/16	7 1/16
74	17	5 1/2	11 1/8	8 7/8	3	1 1/4	11 1/2	8 5/8	11 1/8	8 1/4	8 7/8	6 7/8	3	3 3/4	8 7/8	7
73	17	4 1/2	11 1/8	8 7/8	3	1	11 1/2	8 5/8	11 1/8	8 1/4	8 7/8	6 7/8	3	3 1/2	8 7/8	7
72	17	3 1/2	11 1/16	8 13/16	3	1	11 3/8	8 9/16	11 1/16	8 3/16	8 7/8	6 7/8	3	3 1/4	8 13/16	7
71	17	2 1/2	11	8 3/4	3	0 3/4	11 5/16	8 1/2	11	8 3/16	8 13/16	6 13/16	3	3	8 13/16	6 13/16
70	17	1 1/2	10 13/16	8 11/16	3	0 3/4	11 1/4	8 1/2	10 13/16	8 1/8	8 3/4	6 3/4	3	2 3/4	8 3/4	6 7/8
69	17	0 1/2	10 7/8	8 5/8	3	0 1/2	11 3/16	8 7/16	10 7/8	8 1/16	8 11/16	6 3/4	3	2 1/2	8 3/4	6 7/8
68	16	11 1/2	10 13/16	8 5/8	3	0 1/2	11 1/8	8 3/8	10 13/16	8 1/16	8 11/16	6 3/4	3	2 1/4	8 11/16	6 7/8
67	16	10 1/2	10 13/16	8 9/16	3	0 1/4	11 1/8	8 3/8	10 13/16	8	8 11/16	6 3/4	3	2	8 11/16	6 7/8
66	16	9 1/2	10 3/4	8 9/16	3	0	11 1/16	8 5/16	10 3/4	7 15/16	8 5/8	6 11/16	3	1 7/8	8 5/8	6 13/16
65	16	9 1/2	10 3/4	8 9/16	2	11 3/4	11 1/16	8 5/16	10 3/4	7 13/16	8 9/16	6 11/16	3	1 3/4	8 5/8	6 11/16
64	16	8	10 11/16	8 1/2	2	11 1/2	11	8 5/16	10 11/16	7 11/16	8 1/2	6 11/16	3	1 1/2	8 5/8	6 11/16

Ring						Arms							Palms			
Length from out to out				Size		Length		Distance from Shank	Size				Length and Breadth		thickness	
				Ends	Sides				Throat		Small				Close to Blade	Edge
ft.	in.	ft.	in.	in.	in.	ft.	in.	in.	in.	in.	in.	in.	ft.	in.	in.	in.
3	2 1/2	2	10 1/4	4 15/16	4 11/16	6	5	6	12 15/16	9 13/16	10 3/4	8 5/8	3	3 1/2	3 5/8	2 3/8
3	2 3/8	2	10	4 15/16	4 11/16	6	4 7/8	6	12 7/8	9 3/4	10 11/16	8 9/16	3	3 1/2	3 5/8	2 3/8
3	2 1/4	2	9 7/8	4 15/16	4 11/16	6	4 3/4	6	12 7/8	9 3/4	10 5/8	8 1/2	3	3 1/4	3 1/2	2 3/8
3	2 1/8	2	9 5/8	4 7/8	4 5/8	6	4 1/2	5 7/8	12 7/8	9 11/16	10 9/16	8 7/16	3	3	3 1/2	2 3/8
3	2	2	9 3/8	4 7/8	4 5/8	6	4 1/8	5 7/8	12 3/4	9 5/8	10 9/16	8 7/16	3	3	3 1/2	2 1/4
3	1 7/8	2	9 1/4	4 7/8	4 5/8	6	4 1/8	5 7/8	12 11/16	9 9/16	10 1/2	8 3/8	3	2 3/4	3 3/8	2 1/4
3	1 3/4	2	9 1/8	4 13/16	4 9/16	6	3 7/8	5 3/4	12 5/8	9 1/2	10 7/16	8 5/16	3	2 3/4	3 3/8	2 1/4
3	1 5/8	2	9	4 13/16	4 9/16	6	3 3/4	5 3/4	12 9/16	9 7/16	10 7/16	8 5/16	3	2 1/2	3 3/8	2 1/4
3	1 1/2	2	9	4 13/16	4 9/16	6	3 1/2	5 3/4	12 1/2	9 3/8	10 3/8	8 1/4	3	2 1/2	3 1/4	2 1/4
3	1 3/8	2	8 7/8	4 3/4	4 1/2	6	3 1/4	5 3/4	12 1/2	9 5/16	10 3/8	8 1/4	3	2 1/4	3 1/4	2 1/8
3	1 1/4	2	8 3/4	4 3/4	4 1/2	6	3	5 5/8	12 3/8	9 5/16	10 5/16	8 3/16	3	2 1/4	3 1/4	2 1/8
3	1 1/8	2	8 5/8	4 3/4	4 1/2	6	2 3/4	5 5/8	12 5/16	9 1/4	10 5/16	8 3/16	3	2	3	2 1/8
3	1	2	8 5/8	4 11/16	4 7/16	6	2 1/2	5 5/8	12 1/4	9 1/4	10 1/4	8 1/8	3	2	3	2 1/8
3	0 7/8	2	8 5/8	4 11/16	4 7/16	6	2 1/4	5 5/8	12 3/16	9 3/16	10 3/16	8 1/8	3	1 3/4	3	2 1/8
3	0 3/4	2	8 1/2	4 11/16	4 7/16	6	2	5 1/2	12 1/8	9 3/16	10 1/8	8 1/8	3	1 3/4	2 7/8	2 1/8
3	0 5/8	2	8 1/2	4 5/8	4 3/8	6	1 3/4	5 1/2	12 1/8	9 1/8	10 1/16	8 1/16	3	1 1/2	2 7/8	2 1/8
3	0 1/2	2	8 1/2	4 5/8	4 3/8	6	1 1/2	5 1/2	12	9 1/16	10	8	3	1 1/2	2 7/8	2 1/8
3	0 3/8	2	8 3/8	4 5/8	4 3/8	6	1 1/4	5 1/2	11 15/16	9	10	8	3	1 1/4	2 3/4	2
3	0 1/4	2	8 1/4	4 9/16	4 5/16	6	1	5 3/8	11 7/8	9	9 15/16	7 15/16	3	1 1/4	2 3/4	2
3	0 1/8	2	8 1/8	4 9/16	4 5/16	6	0 5/8	5 3/8	11 13/16	8 15/16	9 7/8	7 7/8	3	1	2 3/4	2
3	0	2	8	4 9/16	4 5/16	6	0 1/4	5 3/8	11 13/16	8 15/16	9 13/16	7 13/16	3	1	2 5/8	2
2	11 7/8	2	7 7/8	4 1/2	4 1/4	6	0	5 3/8	11 3/4	8 7/8	9 3/4	7 3/4	3	0 3/4	2 5/8	2
2	11 3/4	2	7 3/4	4 1/2	4 1/4	5	11 [illegible]	5 1/4	11 3/4	8 7/8	9 3/4	7 3/4	3	0 3/4	2 5/8	2
2	11 5/8	2	7 5/8	4 1/2	4 1/4	5	11 1/4	5 1/4	11 11/16	8 13/16	9 5/8	7 3/4	3	0 1/2	2 5/8	2
2	11 1/2	2	7 1/2	4 7/16	4 3/16	5	11	5 1/4	11 5/8	8 3/4	9 5/8	7 5/8	3	0 1/2	2 1/2	1 7/8
2	11 3/8	2	7 3/8	4 7/16	4 3/16	5	10 5/8	5 1/4	11 9/16	8 11/16	9 9/16	7 5/8	3	0 1/4	2 1/2	1 7/8
2	11 1/4	2	7 1/4	4 7/16	4 3/16	5	10 1/4	5 1/4	11 7/16	8 5/8	9 1/2	7 3/8	3	0 1/4	2 1/2	1 7/8
2	11 1/8	2	7 1/8	4 3/8	4 1/8	5	10	5 1/4	11 3/8	8 5/8	9 7/16	7 9/16	3	0	2 1/2	1 7/8
2	11	2	7	4 3/8	4 1/8	5	9 5/8	5 1/8	11 5/16	8 9/16	9 3/8	7 1/2	3	0	2 3/8	1 7/8
2	10 3/4	2	6 3/4	4 5/16	4 1/16	5	9 3/8	5 1/8	11 1/4	8 9/16	9 5/16	7 1/2	2	11 3/4	2 3/8	1 7/8
2	10 1/2	2	6 1/2	4 5/16	4 1/16	5	9	5 1/8	11 1/4	8 9/16	9 1/4	7 7/16	2	11 1/2	2 3/8	1 7/8
2	10 1/4	2	6 1/4	4 5/16	4 1/16	5	8 5/8	5 1/8	11 3/16	8 1/2	9 1/8	7 3/8	2	11 1/4	2 3/8	1 7/8

Weight	Shank. Length		Shank. Size of Throat		Shank. Increase or swell: Distance from arm		Shank. Increase or swell: Size		Shank. Size: Trend		Shank. Size: Small		Square: Length		Square: Size to Nut	
cwt	ft.	in.	in.	in.	ft.	in.	in.	in.	in.	in.	in.	in	ft.	in.	in.	in.
63	16	7	10 11/16	8 1/2	2	11 1/4	11	8 1/4	10 11/16	7 7/8	8 1/2	6 11/16	3	1 3/8	8 1/2	6 [illegible]
62	16	6	10 5/8	8 1/2	2	11	10 15/16	8 3/16	10 5/8	7 7/8	8 7/16	6 9/16	3	1 1/4	8 1/2	6 1[illegible]
61	16	5	10 5/8	8 7/16	2	11	10 15/16	8 3/16	10 5/8	7 7/8	8 3/8	6 1/2	3	1	8 1/2	6 5/8
60	16	4	10 9/16	8 7/16	2	10 3/4	10 7/8	8 1/8	10 9/16	7 13/16	8 3/8	6 1/2	3	0 3/4	9 3/8	6 5/8
59	16	3	10 9/16	8 7/16	2	10 3/4	10 7/8	8 1/8	10 9/16	7 13/16	8 1/4	6 1/2	3	0 3/8	8 3/8	6 5/8
58	16	2	10 1/2	8 3/8	2	10 1/2	10 13/16	8 1/8	10 1/2	7 13/16	8 3/16	6 7/16	3	0	8 3/8	6 9/16
57	16	1	10 1/2	8 3/8	2	10 1/4	10 13/16	8 1/8	10 1/2	7 3/4	8 3/16	6 7/16	2	11 7/8	8 1/4	6 9/16
56	16	0	10 7/16	8 5/16	2	10 1/4	10 3/4	8 1/16	10 7/16	7 3/4	8 1/8	6 3/8	2	11 1/2	8 1/4	6 1/2
55	15	11	10 7/16	8 5/16	2	10	10 3/4	8 1/16	10 7/16	7 3/4	8 1/8	6 3/8	2	11 1/4	8 1/4	6 1/2
54	15	10	10 3/8	8 1/4	2	9 3/4	10 11/16	8	10 3/8	7 11/16	8 1/16	6 5/16	2	11	8 1/8	6 7/16
53	15	9	10 3/8	8 1/4	2	9 3/4	10 11/16	8	10 3/8	7 11/16	8	6 1/4	2	10 5/8	8 1/8	6 3/8
52	15	8 1/2	10 5/16	8 3/16	2	9 1/2	10 5/8	7 15/16	10 5/16	7 5/8	8	6 1/4	2	10 1/2	8 1/8	6 3/8
51	15	8	10 1/4	8 3/16	2	9 1/4	10 9/16	7 7/8	10 1/4	7 5/8	7 15/16	6 3/16	2	10 1/4	8	6 5/16
50	15	7 1/2	10 3/16	8 1/8	2	9	10 1/2	7 7/8	10 3/16	7 9/16	7 7/8	6 1/8	2	10	7 7/8	6 1/4
49	15	6 1/2	10 1/8	8 1/8	2	8 3/4	10 7/16	7 13/16	10 1/8	7 9/16	7 7/8	6 1/8	2	9 3/4	7 7/8	6 1/4
48	15	5 1/2	10 1/16	8 1/16	2	8 1/2	10 3/8	7 13/16	10 1/16	7 1/2	7 3/4	6 1/8	2	9 1/2	7 3/4	6 1/4
47	15	4 1/2	10 1/16	8 1/16	2	8 1/2	10 3/8	7 13/16	10 1/16	7 1/2	7 11/16	6 1/16	2	9 3/8	7 3/4	6 3/16
46	15	3 1/2	10	8	2	8 1/4	10 5/16	7 3/4	10	7 7/16	7 5/8	6	2	9	7 3/4	6 1/8
45	15	2 1/2	9 15/16	8	2	8	10 1/4	7 11/16	9 15/16	7 7/16	7 9/16	5 15/16	2	8 5/8	7 5/8	6 1/16
44	15	1 1/2	9 15/16	7 15/16	2	8	10 1/4	7 11/16	9 15/16	7 3/8	7 1/2	5 7/8	2	8 1/2	7 5/8	6
43	15	0 1/2	9 7/8	7 15/16	2	7 3/4	10 3/16	7 5/8	9 7/8	7 3/8	7 7/16	5 13/16	2	8 3/8	7 1/2	5 15/16
42	14	11 1/2	9 7/8	7 7/8	2	7 1/2	10 1/8	7 9/16	9 7/8	7 5/16	7 3/8	5 3/4	2	8 1/4	7 1/2	5 7/8
41	14	10 1/2	9 13/16	7 7/8	2	7 1/2	10 1/16	7 1/2	9 13/16	7 1/4	7 5/16	5 11/16	2	8	7 3/8	5 13/16
40	14	10	9 3/4	7 13/16	2	7 1/2	10	7 7/16	9 3/4	7 3/16	7 1/4	5 5/8	2	7 3/4	7 1/4	5 3/4
39	14	9 1/2	9 11/16	7 13/16	2	7 1/2	9 15/16	7 3/8	9 11/16	7 1/8	7 1/4	5 5/8	2	7 3/8	7 1/4	5 3/4
38	14	8 1/2	9 1/2	7 3/4	2	7 1/4	9 3/4	7 5/16	9 1/2	7 1/16	7 1/8	5 5/8	2	7	7 1/8	5 3/4
37	14	7 1/2	9 3/8	7 11/16	2	7	9 5/8	7 1/4	9 3/8	7 1/16	7 1/8	5 5/8	2	6 7/8	7 1/8	5 3/4
36	14	6 1/2	9 1/4	7 5/8	2	6 3/4	9 1/2	7 1/8	9 1/4	6 15/16	7 1/8	5 5/8	2	6 5/8	7 1/8	5 3/4
35	14	5 1/2	9 1/8	7 1/2	2	6 1/2	9 3/8	7 1/16	9 1/8	6 13/16	7 1/16	5 9/16	2	6 3/8	7	5 11[illegible]
34	14	4 1/2	9	7 3/8	2	6 1/2	9 1/4	7	9	6 3/4	7	5 1/2	2	6 1/8	7	5 [illegible]
33	14	3 1/2	8 7/8	7 1/4	2	6 1/4	9 1/8	6 7/8	8 7/8	6 5/8	6 7/8	5 3/8	2	5 3/4	6 7/8	5 [illegible]
32	14	2 1/2	8 3/4	7 1/8	2	6	9	6 7/8	8 3/4	6 9/16	6 13/16	5 5/16	2	5 3/8	6 7/8	5 7/16

Hole from end	Ring: Length from out to out				Ring: Size: Ends	Ring: Size: Sides	Arms: Length		Arms: Distance from Shank	Arms: Size: Throat		Arms: Size: Small		Palms: Length and Breadth		Palms: thickness: Close to Blade	Palms: thickness: Edge
in.	ft.	in.	ft.	in.	in.	in.	ft.	in.	in.	in.	in.	in.	in.	ft.	in.	in.	in.
[illegible]	2	$10\frac{1}{4}$	2	$6\frac{1}{8}$	$4\frac{1}{4}$	4	5	$8\frac{3}{8}$	$5\frac{1}{8}$	$11\frac{3}{16}$	$8\frac{1}{2}$	$9\frac{1}{16}$	$7\frac{5}{16}$	2	$11\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$
[illegible]	2	10	2	6	$4\frac{1}{4}$	4	5	8	5	$11\frac{1}{8}$	$8\frac{1}{2}$	$9\frac{1}{16}$	$7\frac{5}{16}$	2	11	$2\frac{1}{4}$	$1\frac{3}{4}$
[illegible]	2	$9\frac{3}{4}$	2	$5\frac{7}{8}$	$4\frac{1}{4}$	4	5	$7\frac{5}{8}$	5	$11\frac{1}{8}$	$8\frac{7}{16}$	9	$7\frac{1}{4}$	2	$10\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$
[illegible]	2	$9\frac{1}{2}$	2	$5\frac{3}{4}$	$4\frac{3}{16}$	$3\frac{15}{16}$	5	$7\frac{3}{8}$	5	$10\frac{15}{16}$	$8\frac{7}{16}$	9	$7\frac{1}{4}$	2	$10\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{3}{4}$
[illegible]	2	$9\frac{1}{4}$	2	$5\frac{1}{2}$	$4\frac{3}{16}$	$3\frac{15}{16}$	5	7	5	$10\frac{15}{16}$	$8\frac{7}{16}$	$8\frac{15}{16}$	$7\frac{3}{16}$	2	$10\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$
[illegible]	2	9	2	$5\frac{3}{8}$	$4\frac{3}{16}$	$3\frac{15}{16}$	5	$6\frac{5}{8}$	5	$10\frac{7}{8}$	$8\frac{3}{8}$	$8\frac{15}{16}$	$7\frac{3}{16}$	2	10	$2\frac{1}{4}$	$1\frac{3}{4}$
[illegible]	2	$8\frac{3}{4}$	2	$5\frac{1}{8}$	$4\frac{1}{8}$	$3\frac{7}{8}$	5	$6\frac{3}{8}$	$4\frac{7}{8}$	$10\frac{7}{8}$	$8\frac{3}{8}$	$8\frac{7}{8}$	$7\frac{1}{8}$	2	$9\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$
[illegible]	2	$8\frac{1}{2}$	2	$4\frac{7}{8}$	$4\frac{1}{8}$	$3\frac{7}{8}$	5	6	$4\frac{7}{8}$	$10\frac{13}{16}$	$8\frac{5}{16}$	$8\frac{7}{8}$	$7\frac{1}{8}$	2	$9\frac{1}{2}$	$2\frac{1}{8}$	$1\frac{5}{8}$
[illegible]	2	$8\frac{1}{4}$	2	$4\frac{3}{4}$	$4\frac{1}{8}$	$3\frac{7}{8}$	5	$5\frac{5}{8}$	$4\frac{7}{8}$	$10\frac{7}{16}$	$8\frac{5}{16}$	$8\frac{13}{16}$	$7\frac{1}{16}$	2	$9\frac{1}{4}$	$2\frac{1}{8}$	$1\frac{5}{8}$
[illegible]	2	8	2	$4\frac{1}{2}$	$4\frac{1}{16}$	$3\frac{13}{16}$	5	$5\frac{3}{8}$	$4\frac{7}{8}$	$10\frac{3}{4}$	$8\frac{1}{4}$	$8\frac{3}{4}$	7	2	9	$2\frac{1}{8}$	$1\frac{5}{8}$
[illegible]	2	$7\frac{3}{4}$	2	$4\frac{1}{4}$	$4\frac{1}{16}$	$3\frac{13}{16}$	5	5	$4\frac{7}{8}$	$10\frac{3}{4}$	$8\frac{1}{4}$	$8\frac{11}{16}$	$6\frac{13}{16}$	2	$8\frac{3}{4}$	$2\frac{1}{8}$	$1\frac{5}{8}$
[illegible]	2	$7\frac{3}{8}$	2	$4\frac{1}{8}$	$4\frac{1}{16}$	$3\frac{13}{16}$	5	5	$4\frac{3}{4}$	$10\frac{11}{16}$	$8\frac{3}{16}$	$8\frac{5}{8}$	$6\frac{7}{8}$	2	$8\frac{3}{8}$	$2\frac{1}{8}$	$1\frac{5}{8}$
[illegible]	2	$7\frac{1}{8}$	2	$3\frac{7}{8}$	4	$3\frac{3}{4}$	5	$4\frac{3}{8}$	$4\frac{3}{4}$	$10\frac{5}{8}$	$8\frac{3}{16}$	$8\frac{5}{8}$	$6\frac{7}{8}$	2	$8\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{5}{8}$
[illegible]	2	7	2	$3\frac{5}{8}$	4	$3\frac{3}{4}$	5	$4\frac{3}{8}$	$4\frac{3}{4}$	$10\frac{9}{16}$	$8\frac{1}{8}$	$8\frac{9}{16}$	$6\frac{13}{16}$	2	8	$2\frac{1}{8}$	$1\frac{5}{8}$
[illegible]	2	$6\frac{3}{4}$	2	$3\frac{3}{8}$	4	$3\frac{3}{4}$	5	4	$4\frac{3}{4}$	$10\frac{1}{2}$	$8\frac{1}{8}$	$8\frac{1}{2}$	$6\frac{13}{16}$	2	$7\frac{3}{4}$	2	$1\frac{1}{2}$
[illegible]	2	$6\frac{1}{2}$	2	$3\frac{1}{8}$	$3\frac{15}{16}$	$3\frac{11}{16}$	5	$3\frac{5}{8}$	$4\frac{5}{8}$	$10\frac{7}{16}$	$8\frac{1}{16}$	$8\frac{7}{16}$	$6\frac{13}{16}$	2	$7\frac{1}{2}$	2	$1\frac{1}{2}$
[illegible]	2	$6\frac{1}{4}$	2	3	$3\frac{15}{16}$	$3\frac{11}{16}$	5	$3\frac{3}{8}$	$4\frac{5}{8}$	$10\frac{7}{16}$	$8\frac{1}{16}$	$8\frac{3}{8}$	$6\frac{3}{4}$	2	$7\frac{1}{4}$	2	$1\frac{1}{2}$
[illegible]	2	6	2	$2\frac{7}{8}$	$3\frac{15}{16}$	$3\frac{11}{16}$	5	3	$4\frac{5}{8}$	$10\frac{3}{8}$	8	$8\frac{5}{16}$	$6\frac{11}{16}$	2	7	2	$1\frac{1}{2}$
[illegible]	2	$5\frac{3}{4}$	2	$2\frac{5}{8}$	$3\frac{7}{8}$	$3\frac{5}{8}$	5	$2\frac{5}{8}$	$4\frac{1}{2}$	$10\frac{5}{16}$	8	$8\frac{1}{4}$	$6\frac{5}{8}$	2	$6\frac{3}{4}$	2	$1\frac{1}{2}$
[illegible]	2	$5\frac{5}{8}$	2	$2\frac{3}{8}$	$3\frac{7}{8}$	$3\frac{5}{8}$	5	$2\frac{5}{8}$	$4\frac{1}{2}$	$10\frac{5}{16}$	$7\frac{15}{16}$	$8\frac{3}{16}$	$6\frac{9}{16}$	2	$6\frac{5}{8}$	2	$1\frac{1}{2}$
[illegible]	2	$5\frac{1}{2}$	2	$2\frac{1}{4}$	$3\frac{13}{16}$	$3\frac{9}{16}$	5	2	$4\frac{3}{8}$	$10\frac{1}{4}$	$7\frac{15}{16}$	$8\frac{1}{8}$	$6\frac{1}{2}$	2	$6\frac{1}{2}$	2	$1\frac{1}{2}$
[illegible]	2	$5\frac{3}{8}$	2	2	$3\frac{13}{16}$	$3\frac{9}{16}$	5	$1\frac{5}{8}$	$4\frac{3}{8}$	$10\frac{3}{16}$	$7\frac{7}{8}$	$8\frac{1}{16}$	$6\frac{7}{16}$	2	$6\frac{3}{8}$	2	$1\frac{1}{2}$
	2	$5\frac{1}{8}$	2	$1\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{1}{2}$	5	$1\frac{3}{8}$	$4\frac{3}{8}$	$10\frac{1}{8}$	$7\frac{7}{8}$	8	$6\frac{3}{8}$	2	$6\frac{1}{8}$	2	$1\frac{1}{2}$
	2	5	2	$1\frac{5}{8}$	$3\frac{3}{4}$	$3\frac{1}{2}$	5	$1\frac{3}{8}$	$4\frac{1}{4}$	$10\frac{1}{16}$	$7\frac{13}{16}$	$7\frac{7}{8}$	$6\frac{3}{8}$	2	6	2	$1\frac{1}{2}$
	2	$4\frac{5}{8}$	2	$1\frac{3}{8}$	$3\frac{11}{16}$	$3\frac{7}{16}$	5	$1\frac{3}{8}$	$4\frac{1}{4}$	10	$7\frac{13}{16}$	$7\frac{3}{4}$	$6\frac{1}{4}$	2	$5\frac{5}{8}$	$1\frac{7}{8}$	$1\frac{3}{8}$
[illegible]	2	$4\frac{1}{4}$	2	$1\frac{1}{8}$	$3\frac{5}{8}$	$3\frac{3}{8}$	5	$0\frac{5}{8}$	$4\frac{1}{4}$	$9\frac{7}{8}$	$7\frac{3}{4}$	$7\frac{11}{16}$	$6\frac{3}{16}$	2	5	$1\frac{7}{8}$	$1\frac{3}{8}$
[illegible]	2	$4\frac{1}{8}$	2	1	$3\frac{5}{8}$	$3\frac{3}{8}$	5	$0\frac{3}{8}$	$4\frac{1}{8}$	$9\frac{3}{4}$	$7\frac{11}{16}$	$7\frac{5}{8}$	$6\frac{1}{8}$	2	$4\frac{7}{8}$	$1\frac{7}{8}$	$1\frac{3}{8}$
[illegible]	2	$3\frac{7}{8}$	2	$0\frac{7}{8}$	$3\frac{5}{8}$	$3\frac{1}{8}$	5	0	$4\frac{1}{8}$	$9\frac{5}{8}$	$7\frac{5}{8}$	$7\frac{9}{16}$	$6\frac{1}{16}$	2	$4\frac{5}{8}$	$1\frac{7}{8}$	$1\frac{3}{8}$
[illegible]	2	$3\frac{3}{4}$	2	$0\frac{5}{8}$	$3\frac{9}{16}$	$3\frac{5}{16}$	4	$11\frac{5}{8}$	$4\frac{1}{8}$	$9\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$	6	2	$4\frac{1}{2}$	$1\frac{7}{8}$	$1\frac{3}{8}$
[illegible]	2	$3\frac{1}{2}$	2	$0\frac{1}{2}$	$3\frac{9}{16}$	$3\frac{5}{16}$	4	$11\frac{3}{8}$	$4\frac{1}{8}$	$9\frac{3}{8}$	$7\frac{3}{8}$	$7\frac{1}{2}$	6	2	$4\frac{1}{4}$	$1\frac{7}{8}$	$1\frac{3}{8}$
[illegible]	2	$3\frac{1}{4}$	2	$0\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{1}{4}$	4	11	4	$9\frac{1}{4}$	$7\frac{1}{4}$	$7\frac{3}{8}$	$5\frac{7}{8}$	2	4	$1\frac{7}{8}$	$1\frac{3}{8}$
[illegible]	2	3	2	0	$3\frac{1}{2}$	$3\frac{1}{4}$	4	$10\frac{5}{8}$	4	$9\frac{1}{8}$	$7\frac{1}{8}$	$7\frac{3}{8}$	$5\frac{7}{8}$	2	$3\frac{3}{4}$	$1\frac{7}{8}$	$1\frac{3}{8}$

	Shank.												Square			
Weight	Length		Size of Throat		Increase or swell				Size				Length		Size to Nut	
					Distance from arm		Size		Trend		Small					
cwt	ft.	in.	in.	in.	ft.	in.	in.	in.	in.	in.	in.	in	ft.	in.	in.	in.
31	14	1	$8\frac{5}{8}$	7	2	$5\frac{3}{4}$	$8\frac{7}{8}$	$6\frac{3}{4}$	$8\frac{5}{8}$	$6\frac{7}{16}$	$6\frac{3}{4}$	$5\frac{1}{4}$	2	$5\frac{1}{4}$	$6\frac{3}{4}$	$5\frac{3}{8}$
30	14	0	$8\frac{1}{2}$	$6\frac{7}{8}$	2	$5\frac{3}{4}$	$8\frac{3}{4}$	$6\frac{5}{8}$	$8\frac{1}{2}$	$6\frac{3}{8}$	$6\frac{5}{8}$	$5\frac{3}{16}$	2	5	$6\frac{5}{8}$	$5\frac{5}{16}$
29	13	10	$8\frac{3}{8}$	$6\frac{3}{4}$	2	$5\frac{1}{2}$	$8\frac{5}{8}$	$6\frac{1}{2}$	$8\frac{3}{8}$	$6\frac{1}{4}$	$6\frac{9}{16}$	$5\frac{3}{16}$	2	$4\frac{3}{4}$	$6\frac{1}{2}$	$5\frac{5}{16}$
28	13	8	$8\frac{1}{4}$	$6\frac{5}{8}$	2	5	$8\frac{1}{2}$	$6\frac{5}{8}$	$8\frac{1}{4}$	$6\frac{1}{8}$	$6\frac{1}{2}$	$5\frac{1}{8}$	2	$4\frac{3}{4}$	$6\frac{1}{2}$	$5\frac{1}{4}$
27	13	6	$8\frac{1}{8}$	$6\frac{9}{16}$	2	$4\frac{1}{2}$	$8\frac{3}{8}$	$6\frac{3}{8}$	$8\frac{1}{8}$	$6\frac{1}{8}$	$6\frac{7}{16}$	$5\frac{1}{16}$	2	$3\frac{7}{8}$	$6\frac{3}{8}$	$5\frac{3}{16}$
26	13	$4\frac{1}{2}$	8	$6\frac{1}{2}$	2	$4\frac{1}{4}$	$8\frac{1}{4}$	$6\frac{1}{4}$	8	6	$6\frac{3}{8}$	5	2	$3\frac{5}{8}$	$6\frac{3}{8}$	$5\frac{1}{8}$
25	13	$2\frac{1}{2}$	$7\frac{7}{8}$	$6\frac{3}{8}$	2	4	$8\frac{1}{8}$	$6\frac{1}{8}$	$7\frac{7}{8}$	$5\frac{15}{16}$	$6\frac{5}{16}$	$4\frac{15}{16}$	2	$3\frac{1}{8}$	$6\frac{1}{4}$	$5\frac{1}{16}$
24	13	$0\frac{1}{2}$	$7\frac{3}{4}$	$6\frac{1}{4}$	2	$3\frac{3}{4}$	8	$6\frac{1}{16}$	$7\frac{3}{4}$	$5\frac{13}{16}$	$6\frac{1}{4}$	$4\frac{7}{8}$	2	$2\frac{3}{4}$	$6\frac{1}{8}$	5
23	12	$10\frac{1}{2}$	$7\frac{5}{8}$	$6\frac{1}{8}$	2	$3\frac{1}{2}$	$7\frac{7}{8}$	6	$7\frac{5}{8}$	$5\frac{11}{16}$	$6\frac{1}{8}$	$4\frac{3}{4}$	2	$2\frac{1}{2}$	$6\frac{1}{8}$	$4\frac{7}{8}$
22	12	$8\frac{1}{2}$	$7\frac{1}{2}$	6	2	$3\frac{1}{4}$	$7\frac{11}{16}$	$5\frac{7}{8}$	$7\frac{1}{2}$	$5\frac{5}{8}$	6	$4\frac{3}{4}$	2	$2\frac{1}{4}$	6	$4\frac{7}{8}$
21	12	$6\frac{1}{2}$	$7\frac{3}{8}$	$5\frac{7}{8}$	2	3	$7\frac{9}{16}$	$5\frac{3}{4}$	$7\frac{3}{8}$	$5\frac{9}{16}$	$5\frac{15}{16}$	$4\frac{5}{8}$	2	$1\frac{7}{8}$	6	$4\frac{3}{4}$
20	12	6	$7\frac{1}{4}$	$5\frac{3}{4}$	2	$2\frac{3}{4}$	$7\frac{7}{16}$	$5\frac{5}{8}$	$7\frac{1}{4}$	$5\frac{7}{16}$	$5\frac{13}{16}$	$4\frac{9}{16}$	2	$1\frac{5}{8}$	$5\frac{3}{4}$	$4\frac{11}{16}$
19	12	4	$7\frac{1}{8}$	$5\frac{11}{16}$	2	$2\frac{1}{2}$	$7\frac{5}{16}$	$5\frac{9}{16}$	$7\frac{1}{8}$	$5\frac{3}{8}$	$5\frac{3}{4}$	$4\frac{1}{2}$	2	$1\frac{1}{4}$	$5\frac{5}{8}$	$4\frac{5}{8}$
18	12	2	7	$5\frac{5}{8}$	2	$1\frac{3}{4}$	$7\frac{3}{16}$	$5\frac{1}{2}$	7	$5\frac{1}{4}$	$5\frac{5}{8}$	$4\frac{3}{8}$	2	1	$5\frac{1}{2}$	$4\frac{1}{2}$
17	11	10	$6\frac{7}{8}$	$5\frac{9}{16}$	2	$1\frac{3}{4}$	$7\frac{1}{16}$	$5\frac{3}{8}$	$6\frac{7}{8}$	$5\frac{1}{4}$	$5\frac{7}{16}$	$4\frac{5}{8}$	2	$0\frac{3}{4}$	$5\frac{3}{8}$	$4\frac{7}{16}$
16	11	6	$6\frac{3}{4}$	$5\frac{7}{8}$	2	$0\frac{1}{4}$	$6\frac{15}{16}$	$5\frac{5}{16}$	$6\frac{3}{4}$	$5\frac{1}{16}$	$5\frac{5}{16}$	$4\frac{3}{16}$	2	$0\frac{3}{8}$	$5\frac{1}{4}$	$4\frac{5}{16}$
15	11	2	$6\frac{5}{8}$	$5\frac{5}{16}$	1	$11\frac{3}{4}$	$6\frac{13}{16}$	$5\frac{1}{8}$	$6\frac{5}{8}$	5	$5\frac{3}{16}$	$4\frac{1}{16}$	2	0	$5\frac{1}{8}$	$4\frac{3}{16}$
14	10	10	$6\frac{1}{2}$	$5\frac{3}{16}$	1	11	$6\frac{11}{16}$	5	$6\frac{1}{2}$	$4\frac{7}{8}$	$5\frac{1}{16}$	$3\frac{15}{16}$	1	$11\frac{3}{4}$	5	$4\frac{1}{16}$
13	10	$6\frac{1}{2}$	$6\frac{5}{16}$	$5\frac{1}{16}$	1	$10\frac{1}{4}$	$6\frac{1}{2}$	$4\frac{7}{8}$	$6\frac{7}{16}$	$4\frac{3}{4}$	$4\frac{7}{8}$	$3\frac{7}{8}$	1	$11\frac{1}{8}$	$4\frac{7}{8}$	4
12	10	$2\frac{1}{2}$	$6\frac{1}{8}$	$4\frac{7}{8}$	1	$9\frac{3}{4}$	$6\frac{5}{16}$	$4\frac{3}{4}$	$6\frac{3}{8}$	$4\frac{5}{8}$	$4\frac{3}{4}$	$3\frac{3}{4}$	1	$10\frac{7}{8}$	$4\frac{7}{8}$	$3\frac{7}{8}$
11	9	$10\frac{1}{2}$	$5\frac{15}{16}$	$4\frac{11}{16}$	1	$9\frac{1}{4}$	$6\frac{1}{16}$	$4\frac{9}{16}$	$5\frac{15}{16}$	$4\frac{1}{2}$	$4\frac{11}{16}$	$3\frac{11}{16}$	1	$10\frac{1}{2}$	$4\frac{3}{4}$	$3\frac{13}{16}$
10	9	6	$5\frac{3}{4}$	$4\frac{1}{2}$	1	8	$5\frac{7}{8}$	$4\frac{3}{8}$	$5\frac{3}{4}$	$4\frac{3}{8}$	$4\frac{5}{8}$	$3\frac{5}{8}$	1	$10\frac{1}{8}$	$4\frac{1}{2}$	$3\frac{3}{4}$
9	9	3	$5\frac{9}{16}$	$4\frac{7}{16}$	1	$7\frac{1}{2}$	$5\frac{11}{16}$	$4\frac{5}{16}$	$5\frac{9}{16}$	$4\frac{3}{16}$	$4\frac{5}{16}$	$3\frac{7}{16}$	1	9	$4\frac{3}{4}$	$3\frac{9}{16}$
8	9	0	$5\frac{1}{4}$	$4\frac{1}{8}$	1	7	$5\frac{3}{8}$	$4\frac{1}{16}$	$5\frac{1}{4}$	$3\frac{7}{8}$	$4\frac{3}{16}$	$3\frac{5}{16}$	1	$7\frac{7}{8}$	$4\frac{1}{4}$	$3\frac{7}{16}$
7	8	9	5	$3\frac{7}{8}$	1	$6\frac{3}{4}$	$5\frac{1}{8}$	$3\frac{13}{16}$	5	$3\frac{3}{4}$	$4\frac{3}{16}$	$3\frac{5}{16}$	1	$6\frac{7}{8}$	$4\frac{1}{8}$	$3\frac{7}{16}$
6	8	$3\frac{1}{2}$	$4\frac{5}{8}$	$3\frac{5}{8}$	1	$5\frac{3}{4}$	$4\frac{3}{4}$	$3\frac{9}{16}$	$4\frac{5}{8}$	$3\frac{1}{2}$	$3\frac{15}{16}$	$3\frac{1}{16}$	1	$5\frac{3}{4}$	$3\frac{7}{8}$	$3\frac{3}{16}$
5	7	$9\frac{1}{2}$	$4\frac{1}{4}$	$3\frac{1}{4}$	1	$4\frac{3}{4}$	$4\frac{3}{8}$	$3\frac{1}{16}$	$4\frac{1}{4}$	$3\frac{1}{4}$	$3\frac{5}{8}$	$2\frac{7}{8}$	1	$4\frac{5}{8}$	$3\frac{5}{8}$	3
4	7	$3\frac{1}{2}$	$3\frac{7}{8}$	3	1	$3\frac{1}{2}$	4	$2\frac{15}{16}$	$3\frac{7}{8}$	$2\frac{7}{8}$	$3\frac{3}{8}$	$2\frac{5}{8}$	1	$3\frac{1}{2}$	$3\frac{3}{8}$	$2\frac{3}{4}$
3	6	10	$3\frac{5}{8}$	$2\frac{7}{8}$	1	$2\frac{1}{2}$	$3\frac{3}{4}$	$2\frac{13}{16}$	$3\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{13}{16}$	$2\frac{5}{16}$	1	$2\frac{1}{2}$	$2\frac{7}{8}$	$2\frac{7}{16}$
2	5	10	$3\frac{1}{8}$	$2\frac{3}{8}$	1	$0\frac{1}{2}$	$3\frac{1}{4}$	$2\frac{5}{16}$	$2\frac{1}{8}$	$2\frac{3}{8}$	$2\frac{3}{8}$	$1\frac{7}{8}$	1	$0\frac{1}{8}$	$2\frac{1}{2}$	2
1	4	10	$2\frac{3}{4}$	2	0	$10\frac{1}{4}$	$2\frac{7}{8}$	2	$2\frac{3}{4}$	2	$2\frac{1}{8}$	$1\frac{5}{8}$	0	10	$2\frac{1}{4}$	$1\frac{3}{4}$

Hole from end	Ring						Arms							Palms			
	Length from out to out				Size		Length		Distance from Shank	Size				Length and Breadth		thickness	
					Ends	Sides				Throat		Small				Close to Blade	Edge
in.	ft.	in.	ft.	in.	in.	in.	ft.	in.	in.	in.	in.	in.	in.	ft.	in.	in.	in.
4 5/8	2	2 3/4	1	11 3/4	3 7/16	3 3/16	4	10	4	9	7	7 1/4	5 13/16	2	3 1/2	1 3/4	1 1/4
4 5/8	2	2 1/2	1	11 1/2	3 7/16	3 3/16	4	9 5/8	4	8 7/8	6 7/8	7 1/8	5 3/4	2	3 1/4	1 3/4	1 1/4
4 1/2	2	2 1/4	1	11 1/4	3 3/8	3 1/8	4	9	3 7/8	8 3/4	6 3/4	7 1/16	5 11/16	2	3	1 3/4	1 1/4
4 1/2	2	1 7/8	1	11	3 3/8	3 1/8	4	8 3/8	3 7/8	8 5/8	6 5/8	7	5 5/8	2	2 5/8	1 3/4	1 1/4
4 1/2	2	1 1/2	1	10 3/4	3 5/16	3 1/16	4	7 5/8	3 7/8	8 1/2	6 9/16	7	5 5/8	2	2 1/4	1 3/4	1 1/4
4 1/2	2	1 1/4	1	10 1/2	3 5/16	3 1/16	4	7	3 3/4	8 5/8	6 1/2	6 15/16	5 9/16	2	2	1 3/4	1 1/4
4 1/4	2	0 7/8	1	10 1/4	3 1/4	3	4	6 5/8	3 3/4	8 1/4	6 3/8	6 7/8	5 1/2	2	1 5/8	1 3/4	1 1/4
4 1/4	2	0 1/2	1	9 7/8	3 3/16	2 15/16	4	5 5/8	3 3/4	8 1/8	6 1/4	6 3/4	5 7/16	2	1 1/4	1 3/4	1 1/4
4 1/4	2	0 1/4	1	9 5/8	3 3/16	2 15/16	4	5	3 5/8	8	6 1/8	6 5/8	5 3/8	2	1	1 5/8	1 1/8
4	2	0	1	9 3/8	3 1/8	2 7/8	4	4 3/8	3 5/8	7 13/16	6	6 1/2	5 1/4	2	0 3/4	1 5/8	1 1/8
4	1	11 3/4	1	9 1/8	3 1/8	2 7/8	4	3 5/8	3 5/8	7 11/16	5 7/8	6 3/8	5 1/8	2	0 1/2	1 5/8	1 1/8
4	1	11 1/2	1	9	3 1/16	2 13/16	4	3 3/8	3 1/2	7 9/16	5 3/4	6 5/16	5 1/16	2	0 1/4	1 5/8	1 1/8
3 3/4	1	11 1/4	1	8 3/4	2 15/16	2 11/16	4	2 5/8	3 1/2	7 3/16	5 11/16	6 3/16	4 15/16	1	11 3/4	1 5/8	1 1/8
3 3/4	1	11	1	8 1/2	2 7/8	2 5/8	4	2	3 3/8	7 5/16	5 5/8	5 15/16	4 13/16	1	11 1/2	1 1/2	1
3 3/4	1	10 3/4	1	8 1/4	2 13/16	2 9/16	4	0 5/8	3 3/8	7 3/16	5 6/16	5 3/4	4 5/8	1	11 1/4	1 1/2	1
3 1/2	1	10 1/2	1	8	2 3/4	2 1/2	3	11 3/8	3 3/8	7 1/16	5 7/16	5 5/8	4 1/2	1	11	1 1/2	1
3 1/2	1	10 1/4	1	7 5/8	2 11/16	2 7/16	3	10	3 1/4	6 15/16	5 5/16	5 1/2	4 3/8	1	10 3/4	1 1/2	1
3 1/2	1	10	1	7 3/8	2 5/8	2 3/8	3	8 5/8	3 1/4	6 13/16	5 3/16	5 3/8	4 1/4	1	10 1/2	1 1/2	1
3 1/4	1	9 5/8	1	7 1/8	2 9/16	2 5/16	3	7 3/8	3 1/8	6 5/8	5 1/16	5 3/16	4 3/16	1	10 1/8	1 1/2	1
3 1/4	1	9 1/4	1	6 7/8	2 1/2	2 1/4	3	6	3 1/8	6 7/16	4 7/8	5 1/16	4 1/16	1	9 3/4	1 5/8	7/8
3 1/4	1	8 7/8	1	6 1/4	2 7/16	2 3/16	3	4 5/8	3 1/8	6 3/16	4 11/16	4 15/16	3 15/16	1	9 3/8	1 3/8	7/8
3	1	8 1/2	1	5 3/4	2 7/16	2 3/16	3	3	3	6	4 1/2	4 7/8	3 7/8	1	9	1 3/8	7/8
3	1	7 1/2	1	5 3/8	2 1/4	2 1/16	3	2	3	6 13/16	4 7/16	4 9/16	3 11/16	1	8	1 3/8	7/8
3	1	6 1/2	1	4 1/2	2 1/4	2 1/16	3	1	2 7/8	5 5/8	4 1/8	4 3/8	3 5/8	1	7	1 1/4	3/4
2 3/4	1	5 1/2	1	3 3/4	2 1/4	2 1/16	3	0	2 7/8	5 3/8	3 7/8	4 1/4	3 1/2	1	6	1 1/4	3/4
2 3/4	1	4 1/2	1	2 7/8	2 3/16	2	2	10	2 3/4	5	3 5/8	4 1/8	3 3/8	1	5	1 1/8	3/4
2 3/4	1	3 1/2	1	2	2 1/16	1 7/8	2	8	2 3/4	4 5/8	3 1/4	4 7/8	3 1/8	1	4	1 1/8	3/4
2 1/2	1	2 1/2	1	1	1 15/16	1 3/4	2	6	2 5/8	4 1/4	3	3 1/2	2 7/8	1	3	1	5/8
2 1/2	1	1 1/2	1	0 1/4	1 9/16	1 3/8	2	4	2 5/8	4	2 7/8	3	2 3/8	1	2	7/8	5/8
2 1/4	0	11 1/2	0	10 1/4	1 7/16	1 1/4	2	0	2 1/2	3 1/2	2 3/8	2 5/8	2	1	0	7/8	5/8
1 3/4	0	8 1/2	0	7 1/4	1 5/16	1 1/8	1	8	2 1/2	3 1/8	2	2 3/8	1 3/4	0	8 1/2	3/4	9/16

Rule for determining the Length and Size of an Anchor-Stock.

Length of the Shank, and half the Diameter of the Ring, to be the Length of the Stock.

SIZE—Square one Inch to a Foot for the Middle, and half an Inch for the Ends.

Iron Stocks for Anchors.	Size to Forelock Hole.	As the Size of the Small of the Shank.
	Length.	Length of the Shank and half the Diameter of the Ring.

A TABLE

OF

Proportionate Weights of Anchors, and Sizes of Hempen and Iron Cables,

SUITABLE TO THE TONNAGE OF EVERY CLASS OF VESSELS.

Rate	Guns	Tons	Anchors. Sheet or Storm Cwt.	No.	Anchors. Bower Cwt.	No.	Hempen and Iron Cables to suit. Hempen ins. circum	Iron as Substitutes ins. diam.	Anchors stream Cwt.	No	kedge Cwt.	No.	Observations
1st	120	2600	98	1	95	3	25½	$2\frac{1}{8}$	21	1	11 5	1 1	*One or two cwt. on anchors of heavy weight, more or less, is of little or no moment: when the bower anchors are not of even weight, one should be as much heavier as the other is too light.*
		2542	97	1	94	3			21	1	11 5	1 1	
		2484	96	1	93	3			21	1	11 5	1 1	
		2426	95	1	92	3	25		21	1	11 5	1 1	
		2368	94	1	91	3			21	1	11 5	1 1	
		2309	93	1	90	3			21	1	11 5	1 1	
	100	2250	92	1	89	3	24½		21	1	11 5	1 1	
2d	84	2217	91	1	88	3			18	1	9 4	1 1	
		2184	90	1	87	3	24		18	1	9 4	1 1	
		2151	89	1	86	3			18	1	9 4	1 1	
		2118	88	1	85	3			18	1	9 4	1 1	
		2084	87	1	84	3			18	1	9 4	1 1	
		2050	86	1	83	3			18	1	9 4	1 1	
		2019	85	1	82	3	23½	$2\frac{1}{16}$	18	1	9 4	1 1	
		1988	84	1	81	3			18	1	9 4	1 1	
	80	1957	83	1	80	3			18	1	9 4	1 1	
3d	78	1926	82	1	79	3			17	1	8	1	
		1895	81	1	78	3			17	1	8	1	
		1864	80	1	77	3	23		17	1	8	1	
		1832	79	1	76	3			17	1	8	1	
		1800	78	1	75	3			17	1	7	1	
		1779	77	1	74	3			17	1	7	1	
		1758	76	1	73	3			17	1	7	1	
		1737	75	1	72	3	22½		17	1	7	1	

Rate	Guns	Tons	Anchors: Sheet or Storm		Anchors: Bower		Hempen and Iron Cables to suit: Hempen	Hempen and Iron Cables to suit: Iron as Substitutes	Anchors: stream		Anchors: kedge		Observations
			Cwt.	*No.*	*Cwt.*	*No.*	*ins. circum.*	*ins. diam.*	*Cwt.*	*No.*	*Cwt.*	*No.*	
3d	78	1716	74	1	71	3			17	1	7	1	*The size of the hempen and iron cables, as shewn in the table, is in proportion only to the bower anchor. The size of the cables, as appropriate to the storm, stream, and kedge anchors, is as shewn against their respective weights.*
		1693	73	1	70	3		2	16	1	7	1	
		1670	72	1	69	3			16	1	6	1	
		1647	71	1	68	3			16	1	6	1	
		1624	70	1	67	3	22		16	1	6	1	
		1600	69	1	66	3			16	1	6	1	
		1579	68	1	65	3			16	1	6	1	
		1550	67	1	64	3			16	1	6	1	
		1537	66	1	63	3			16	1	6	1	
		1515	65	1	62	3	$21\frac{1}{2}$		16	1	6	1	
		1493	64	1	61	3			16	1	6	1	
		1471	64	1	60	3			16	1	6	1	
4th	60	1448	63	1	59	3		$1+\frac{5}{6}$	15	1	6	1	
		1425	62	1	58	3	21		15	1	6	1	
		1400	61	1	57	3			15	1	6	1	
		1373	60	1	56	3	$20\frac{1}{2}$		12	1	6	1	
		1346	59	1	55	3			12	1	6	1	
		1318	58	1	54	3	20		12	1	6	1	
		1290	57	1	53	3			12	1	5	1	
		1261	56	1	52	3	$19\frac{1}{2}$		12	1	5	1	
		1232	55	1	51	3			11	1	5	1	
		1200	54	1	50	3			11	1	5	1	
		1172	53	1	49	3	19		11	1	5	1	
5th	48	1144	52	1	48	3		$1\frac{7}{8}$	10	1	5	1	
		1116	51	1	47	3	$18\frac{1}{2}$		10	1	5	1	
		1088	50	1	46	3			10	1	5	1	
		1060	49	1	45	3			10	1	5	1	
		1031	48	1	44	3	18		10	1	5	1	
		1000	47	1	43	3		$1\frac{3}{4}$	10	1	5	1	
		972	46	1	42	3			10	1	5	1	
		944	45	1	41	3	$17\frac{1}{2}$		10	1	5	1	
		916	44	1	40	3			10	1	4	1	
		887	43	1	39	3			10	1	4	1	
		858	42	1	38	3	17	$1\frac{5}{8}$	9	1	4	1	
		829	41	1	37	3			9	1	4	1	
		800	40	1	36	3	$16\frac{1}{2}$		9	1	4	1	
		767	39	1	35	3			9	1	4	1	
		734	38	1	34	3	16		9	1	4	1	
		701	37	1	33	3			9	1	4	1	

Rate	Guns	Tons	Anchors: Sheet or Storm		Anchors: Bower		Hempen and Iron Cables to suit: Hempen	Hempen and Iron Cables to suit: Iron as Substitutes	Anchors: stream		Anchors: kedge		Observations
			Cwt.	No.	Cwt.	No	ins. circum	ins. diam.	Cwt.	No.	Cwt.	No.	
5th		668	36	1	32	3	15½	1½	9	1	4	1	*N. B. If the weight of the anchors as herein stated be considered too heavy for the respective tonnage, less may be taken; but this should be with respect to cutters, in consideration of their having but one mast, or with vessels built for fast sailing, whose actual capacity is less than their common admeasurement.*
		634	35	1	31	3			9	1	4	1	
6th	34	600	34	1	30	3	15		8	1	4	1	
		567	33	1	29	3			8	1	3	1	
		534	32	1	28	3	14½		8	1	3	1	
		501	31	1	27	3			8	1	3	1	
ship sloop	20	468	30	1	26	2	14	1⅜	7	1	3	1	
		434	29	1	25	2			7	1	3	1	
		420	28	1	24	2	13½		7	1	3	1	
	18	390	27	1	23	2			7	1	3	1	
		375	26	1	22	2	13	1¼	7	1	3	1	
small 3 mast vessels, brigs, and schooners		345	25	1	21	2			7	1	3	1	
		300	24	1	20	2	12½		7	1	3	1	
		280	22	1	19	2			6	1	3	1	
		270	21	1	18	2	12		6	1	3	1	
		250	20	1	17	2		1⅛	6	1	3	1	
		225	19	1	16	2	11½		6	1	3	1	
		190	18	1	15	2			6	1	3	1	
		170	17	1	14	2	11	1	4	1	2	1	
		145	16	1	13	2			4	1	2	1	
		130	15	1	12	2	10½	15/16	4	1	2	1	
		115	13	1	11	2	10		4	1	2	1	
		100	12	1	10	2	9½	⅞	4	1	2	1	
cutters		90	11	1	9	2	9		4	1	2	1	
		80	10	1	8	2	8½	13/16	3	1	2	1	
		70	9	1	7	2	8		3	1	2	1	
		60	8	1	6	2	7½	¾	3	1	2	1	
		50	6	1	5	2	7		2	1	1	1	
		40	5	1	4	2	6½	11/16	2	1	1	1	
		30	4	1	3	2	6		2	1	1	1	
		20	3	1	2	2	5	⅝	1	1	1	1	
		10	1½	1	1	2	4	½					

CONTENTS.

CONTENTS.

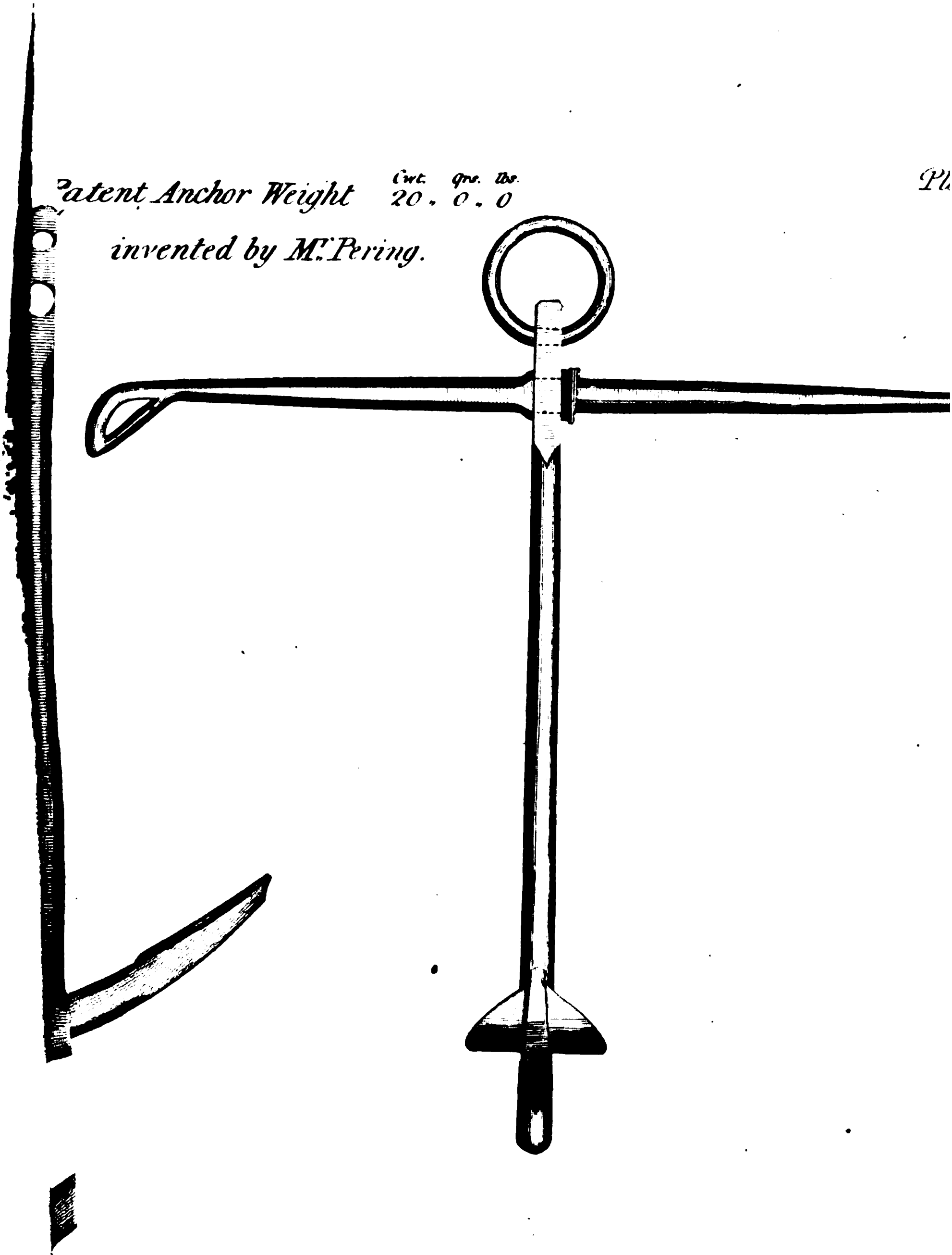
CONTENTS.

PLYMOUTH-DOCK:
Printed by Congdon and H... rle, Telegraph-Office.

Patent Anchor Weight Cwt. Qrs. lbs. 20 . 0 . 0

Pl.

invented by Mr. Pering.



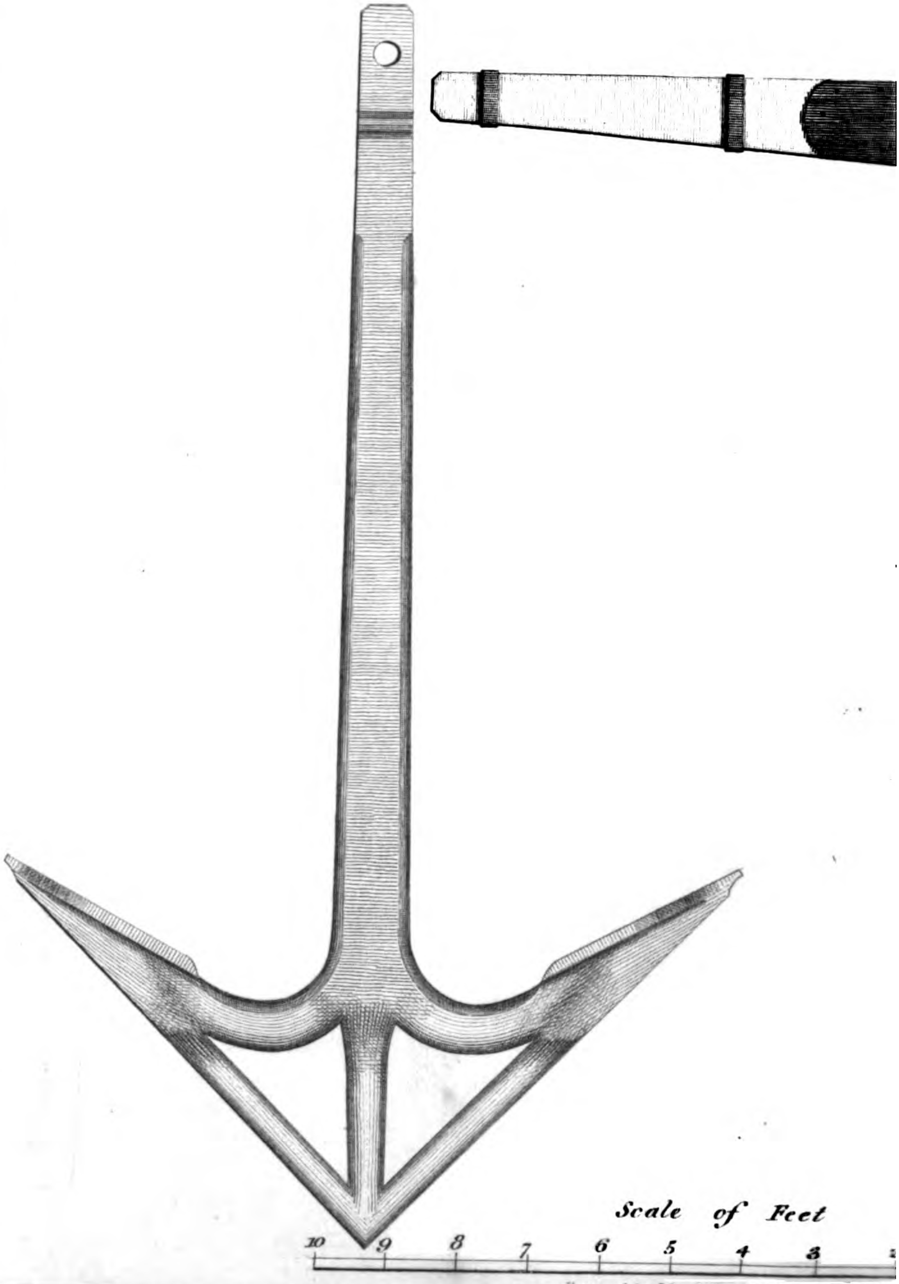
Scale of Feet

9 8 7 6 5 4 3 2 1

Engraved by J. Cooke. Stonehouse

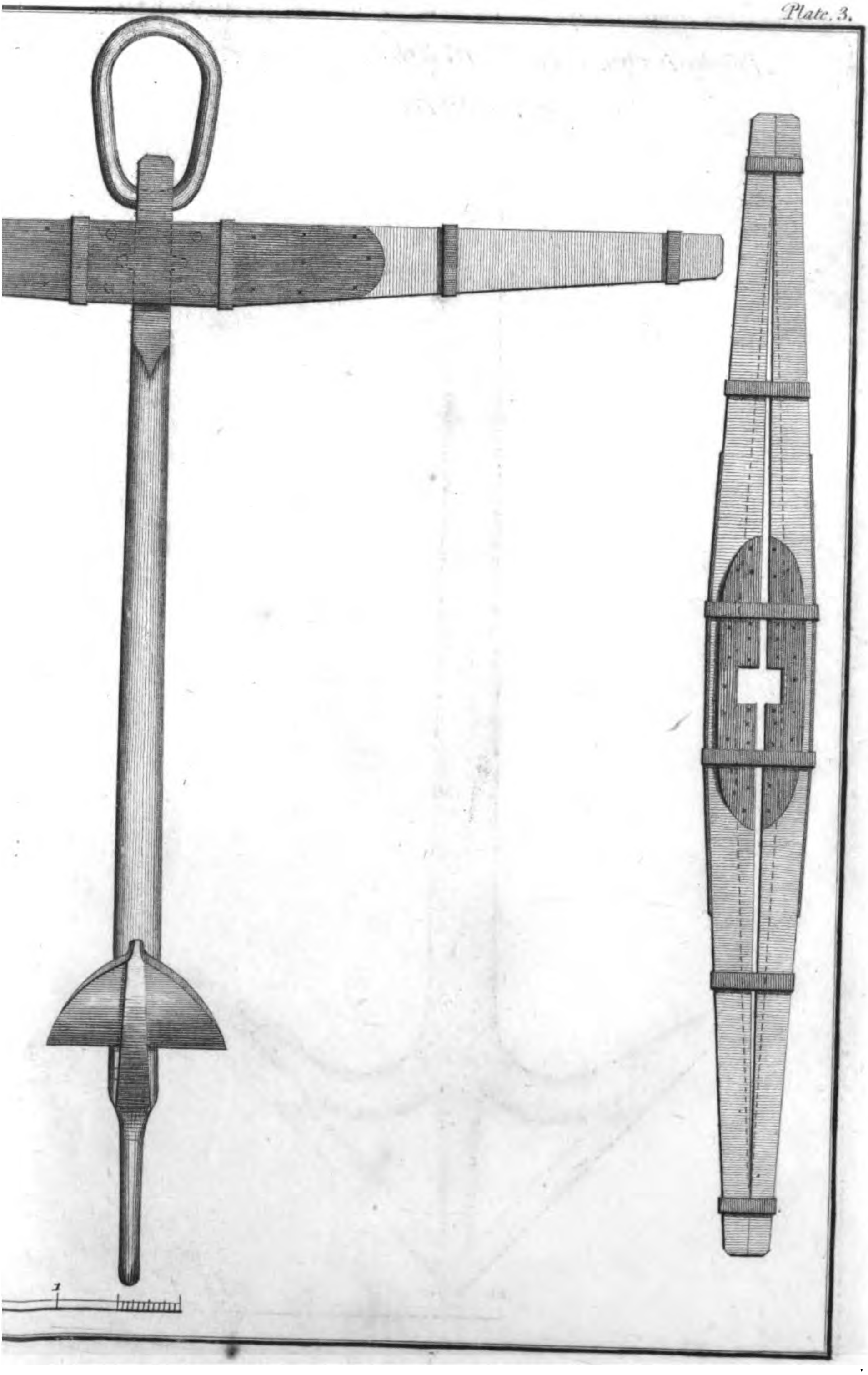
Anchor Open Truss. Weight, Cwt. 73 „ qrs. 3 „ lbs. 0

invented by Mr. Pering.

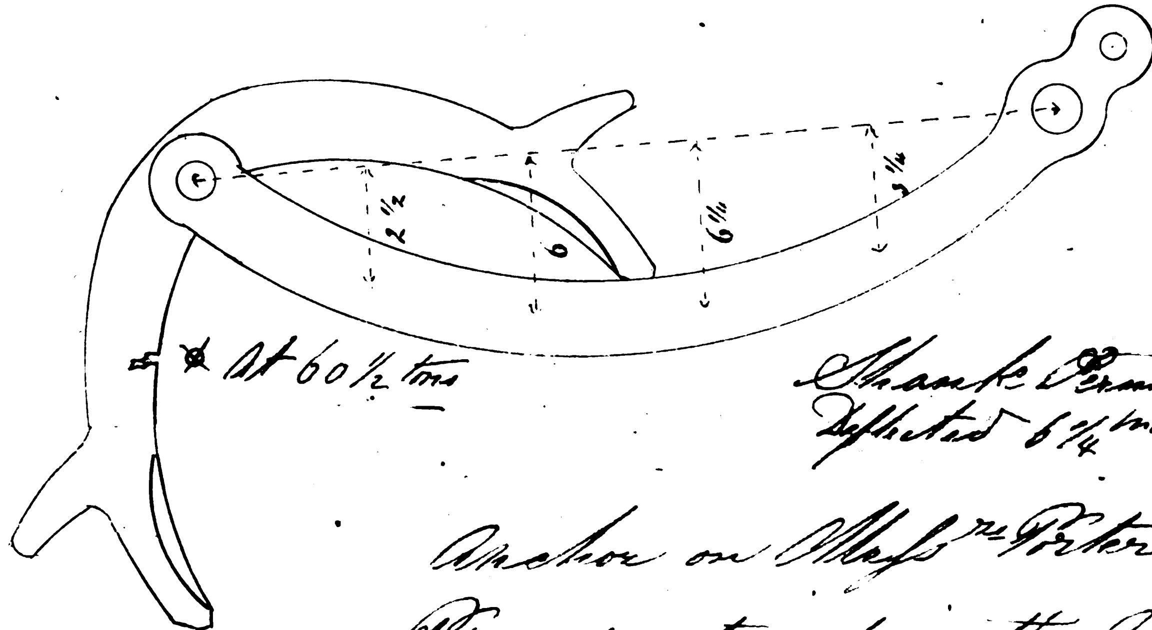


Engraved by John Cooke Stonehouse Plym

Plate. 3.



23^d^ Feb: 1842



Shank Permanent
Deflected 6¼ inches

Anchor on Mess^rs^ Porter's
Plan was tried in the usual
way weighing 2 8-0-0 cwt qr lb with
the Strain of 27 1/8 tons Arm came back